GEI Consultants

Geotechnical
Environmental and
Water Resources
Engineering

Lower Llagas Creek Capacity Restoration Capital Project

Geotechnical Evaluation Report

Submitted to:
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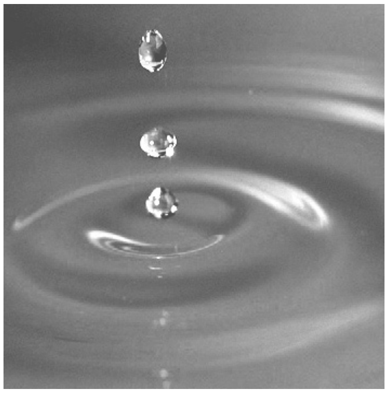

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1. Introduction

1.1 Project Purpose and Scope

The Lower Llagas Creek Capacity Restoration Project (Project) is located along Llagas Creek from its confluence with the Pajaro River in the south to the Pacheco Pass Highway in the north. The site vicinity and Project location are shown in **Figure 1**. This portion of the creek is located in both the City of Gilroy and unincorporated Santa Clara County, extends for about 18,000 feet (3.4 miles), and includes Reaches 1 and 2 (2A and 2B). The existing improvements to Lower Llagas Creek Reaches 1 and 2 were designed by the USDA Soil Conservation Service (now Natural Resources Conservation Service; federal sponsor) and constructed between 1973 and 1985. As the local sponsor of the project, the District became responsible for the operation and maintenance improvements in these reaches. This maintenance work has included low-flow channel reestablishment, vegetation maintenance, and grading of maintenance roads.

In 1997, a pair of least Bell's vireo, a federally-listed endangered species, was observed in the project area[1]. Since then channel maintenance has not been performed. Subsequent sediment buildup and vegetation growth in the channel has reduced the creek cross-sectional area and the channel's ability to adequately convey flood flows. In response, the District is undertaking the current project to assess the flood risk in Reaches 1 and 2 and determine what types of remedial actions are necessary. The overall goal of the Project is to provide flood protection for homes, businesses, and agricultural land in southern Santa Clara County, to protect and improve water quality in the watershed, and to preserve and enhance the river's habitat, fish, and wildlife.

GEI Consultants (GEI), together with Cal Engineering & Geology (CE&G), and Pacific Geotechnical Engineering (PEG) (the GEI Team), is providing the District with the services needed to evaluate the geotechnical aspects of the existing levees, assist in assessing the feasibility of various alternative design concepts to improve flood protection, and support the design of capacity restoration efforts by the District. Specifically, the purpose of this geotechnical engineering study is to:

- Assess the current conditions of the existing levees and channel slopes within Reaches 1, 2A, and 2B to identify any geotechnical deficiencies in terms of slope stability, seepage, and settlement with reference to United States Army Corps of Engineers (USACE) guidelines, Federal Emergency Management Agency (FEMA) standards, and the District's Levee Safety Technical Guidance Manual (District Standards).

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[1] In addition to the least Bell's vireo, a number of sensitive species have been identified in the project area, including the Western Pond Turtle and White-tailed Kite.

- Evaluate the feasibility of raising the height of the existing levees by up 3.5 feet by constructing flood walls, adding compacted fill, or construction of an earth retention system on top of the existing levees.
- Evaluate the potential for liquefaction and perform liquefaction-induced lateral spreading and settlement analyses.
- Provide geotechnical recommendations for constructing floodwalls, raising the levee with compacted fill, or constructing earth retaining structures, and provide recommendations for remedial design criteria for deficient areas.

This report describes and summarizes the results of our geotechnical engineering evaluation of the Lower Llagas Creek channel levees within the identified study Reach.

1.2 Project Personnel

The geotechnical studies described in this report were coordinated with the following individuals from the District:

- Bill Springer – District Project Manager
- Bal Ganjoo – District Senior Project Manager
- Joseph Brunner – District Geotechnical Engineer
- Doug Padley – District Wildlife Biologist
- Tiffany Hernandez – District Environmental Planner, CEQA Coordinator
- Peter Jackson – District Environmental Health and Safety Manager

Key personnel who participated in this project include:

- Mark Freitas, GEI Consultants – Principal Geotechnical Engineer/Project Manager
- Len Sansone, GEI Consultants – Principal Geotechnical Engineer
- Matt Powers, GEI Consultants – Project Geologic Engineer
- Tim Haynes, GEI Consultants – Staff Geotechnical Engineer
- Phil Gregory, Cal Engineering and Geology – Principal Geotechnical Engineer
- Dave Burger, Cal Engineering and Geology – Project Geologist
- Beeson Liang, Pacific Geotechnical Engineering – Principal Geotechnical Engineer
- G. Reid Fisher, Pacific Geotechnical Engineering – Senior Geologist

1.3 Surveys, Datums, and Units of Measure

A LiDAR survey was conducted for the District on February 15, 2007, by Airborne1 of El Segundo, CA, which included the Lower Llagas Creek Project area. This survey was collected and processed using airborne GPS to produce a bare earth surface model at a 1-foot contour interval. Project photography was acquired on March 5, 2007, consisting of twenty-six color exposures at 1:3000 flown in three flight lines. The flight was made by Pacific

Aerial Surveys; a subsidiary company of HJW GeoSpatial. Control for the LiDAR and photography processing was established, targeted, and surveyed by GPS methods by Tucker & Associates of Calistoga, CA. Twenty-six points were paneled for photo-triangulation. SCVWD points 892 (Federal PID GU2656), 934 (HS2738) and 938 (GU3630) were included in the network for control. SCVWD BMs 010, 262 and 263 were also used to establish the vertical datum. The horizontal control network was tied to the North American Datum of 1983 (NAD83), epoch 2004.082. The survey was projected to the California State Plane Coordinate System, Zone 3. Elevations are based upon the North American Vertical Datum of 1988 (NAVD88). The mapping units are US Survey Feet.

Information from the LiDAR survey, including top of levee, landside area, and channel invert elevations, was used to estimate ground surface elevations of the geotechnical investigation locations, and to develop topographical profiles and sections for use in project analyses and evaluations. The coordinates and ground surface elevations of the exploration locations are presented in **Table 1**. Additionally, in July 2012, Carnes and Associates, of Gilroy, CA, performed a field survey of the final geotechnical exploration locations performed for the project study. Data from this field survey was provided to the District for future project use. The existing levee stationing, as assigned by the District in the 2009 Project plan topography drawings, was adopted for this project study and referenced in this report. The U.S. customary system of units (foot-pound-second) has generally been used for consistency with previous studies.

2. Project Information and Site Description

2.1 Project Study Area and Evaluation

Llagas Creek extends approximately 30 miles from the confluence with the Pajaro River to Mount Loma Prieta in the Santa Cruz Mountains. The creek flows in a roughly southeasterly direction from Chesbro Reservoir, and draining portions of the cities of San Jose, Morgan Hill, and Gilroy, as well as unincorporated Santa Clara County. The Llagas Creek watershed has an area of approximately 90 square miles that is bound by the Uvas Creek watershed to the southwest and the Coyote Creek watershed to the northeast.

The Lower Llagas Creek Project study area is located in Gilroy and portions of unincorporated Santa Clara County, and includes Reaches 1, 2A and 2B of Llagas Creek. This portion of Llagas Creek extends approximately 3.4 miles from the confluence with the Pajaro River at the southern extent (Station 0+00) northward to the Pacheco Pass Highway (CA 152) overpass structure (Station 176+50). Reaches 1, 2A and 2B are engineered channels and intended to provide flood protection for the surrounding developed areas which include residential, industrial, and agricultural properties. A map of the site vicinity and the Project study area is shown on **Figure 1**.

As Discussed in the District's *Problem Definition and Refined Objectives Report* for the Lower Llagas Creek Capacity Restoration Project (SCVWD, 2010), the District is evaluating the existing channel in regard to providing 100, 50, 25, or 10-year flood protection, as follows:

- Reach 1: Station 0+00 to 27+80 – Evaluated using 10-year flowrate (9,500 cfs)
- Reach 1: Station 27+80 to 45+35 – Evaluated using 25-year flowrate (13,200 cfs)
- Reach 1: Station 45+35 to 61+90 – Evaluated using 50-year flowrate (16,000 cfs)
- Reach 2A: Station 61+90 to 126+60 – Evaluated using 100-year flowrate (18,800 cfs)
- Reach 2B: Station 126+60 to 176+50 – Evaluated using 100-year flowrate (18,500 cfs)

In summary, problems related to hydraulic deficiencies of the Lower Llagas Creek channel, as reported by the District, include:

- Channel overtopping and inadequate freeboard (0.1 to 3.3 feet) for approximately 1500 feet of Reach 1, from Bloomfield Avenue to Reach 2A.
- Inadequate freeboard (0.2 to 3 feet) for 1.0 miles of Reach 2A, from 0.5 miles upstream of Bloomfield Avenue to Southside Drive.
- Inadequate freeboard (0.2 to 2 feet) for 0.5 mile of Reach 2B, from Southside Drive to 0.5 miles upstream of Southside Drive.

- Channel overtopping on the west bank at the Miller Slough confluence.

A summary of hydraulic deficiencies along the Lower Llagas Creek channel study area is included in **Table 2**, provided by the District.

Based on preliminary geotechnical engineering investigations and observations by the District personnel in 2009, it was concluded that in general, the existing levees along the project reaches are in stable condition and there is no immediate threat to the structural integrity and safety of these levees (see the District's 2010 *Problem Definition and Refined Objectives Report,* Appendix E). It is noted that the current levees have not experienced the design flow levels. Additional geotechnical investigations, analyses, and evaluations, as discussed in this report, were performed to assist the District in assessing the feasibility of various alternative design concepts to improve flood protection, and support the design of capacity restoration efforts, as mentioned above.

It should be noted that the southern portion of Reach 1, between Bloomfield Avenue and the confluence with the Pajaro River (Station 0+00 to 47+00), was not evaluated as part of this study, as the District elected to exclude this portion of Reach 1 from the overall Project geotechnical evaluation. No site investigations or analyses were performed nor are recommendations provided for this reach of the Project area.

2.2 Construction History and Levee Past Performance

Flooding along Lower Llagas Creek has been recorded since at least the mid-1800s. Historically, portions of southern Santa Clara County, including the Project area, were associated with high ground water elevations with artesian flow characteristics. During early agricultural development in the area, there was little need for irrigation ditches, with exception to a few surface diversions used primarily for winter irrigation. Most of this area supported seasonal or perennial wetlands, especially in the vicinity of Llagas Creek. Individual farmers in the area would dig ditches to drain their land in response to the frequent flooding experienced throughout this area, in order to maintain arable lands for a variety of agricultural purposes. As agriculture land use increased in the region, the network of drainage ditches and flood control features expanded to protect against flood damages.

In more recent history, floods have been recorded in 1937, 1955, 1958, 1962, 1963, 1969, 1982, 1986, 1996, 1997, 1998, 2002, and 2008, with the largest recorded flood, estimated to be a 33-year event, occurring in December 1955. Flooding was addressed regionally with the passage of the Watershed Protection and Flood Prevention Act (PL 83-566) in 1954. Through the federal PL 566 program, planning, design, and construction of Reach 1 was completed in 1973, followed by Reach 2A in 1984, and Reach 2B in 1985. The following were part of the PL 566 construction:

Reach 1 – New levees were constructed on both sides of Llagas Creek from the Pajaro River confluence to 1500 feet north of Bloomfield Road (approximate Station 62+00). The levees were set back from the original levees, effectively widening the channel and increasing the flow capacity. The old levees within the channel were degraded and a low-flow channel established. The channel widths in this reach (waterside levee hinge point to hinge point), measured from satellite imagery, are approximately 200 feet. Mitigation plantings were placed along the levee side slopes on the landside of Reach 1.

Reach 1 Construction specifications called for ‘semi-compacted fill’ placed within the inner portion of the levee prism and a zone of ‘loose-fill’ placed on the landside slope of the ‘semi-compacted’ portion of the levee, as shown on project drawings. The ‘semi-compacted fill’ was to be placed in loose lifts with maximum thickness of 9-inches, with each lift compacted by not less than four complete passes of sheeps-foot tamping roller weighing between 1200 and 1400 pounds per foot width of roller. The loose fill on the outer shell was not compacted and apparently placed for growing plants and vegetation.

Reach 2A - Similar to Reach 1, new levees were constructed in Reach 2A (1500 feet north of Bloomfield Road to Southside Drive). The new levees provided higher crest elevations throughout the reach and were set back from the original levees to widen the channel and increase flow capacity. Temporary setback ‘phase levees’ were constructed along the west bank of Reach 2A in order to maintain flood protection while the old levees were degraded. These ‘phase levees’ were incorporated into the prism of the new levees following degrading of the old levees. Two rip-rap hydraulic grade control structures were constructed within Reach 2A. Channel widths in this reach are approximately 200 to 300 feet. A low-flow channel was established and mitigation plantings were placed along the landside, waterside, and levee crest for portions of Reach 2A.

Reach 2B – New levees were constructed and a new channel alignment established in Reach 2B (Southside Drive to Highway 152). In general, the levees were smaller in size compared to those constructed in Reach 1 and Reach 2A. A wider channel was excavated within this reach, increasing flow capacity, and small levees and berms were constructed adjacent to the channel. Three rip-rap hydraulic grade control structures were constructed within Reach 2B. Channel widths in this reach are approximately 175 to 275 feet. A low-flow channel was established and mitigation plantings were placed along the landside, waterside, and levee crest for portions of Reach 2B.

Reach 2A and Reach 2B construction specifications called for compacted fill forming the entire levee prism. Compacted fill was to be placed in loose lifts with maximum thickness of 9-inches and moisture conditioned to within 2% of optimum moisture content. The compaction specifications typically called for 90 percent relative compaction based on the ASTM D698 standard.

In general, the levees within Reach 1, 2A and 2B of lower Llagas Creek were typically designed with 2:1 (H:V) slopes. The specifications also indicate that the levees were constructed with native silty or clayey fill materials obtained from channel excavations. Portions of the creek were also straightened, particularly in Reach 2B. The general shape and structure of the existing levees appear to be intact, based on observations of the District's previous geotechnical investigations and site-specific observations performed for this Project study. However, during Project site reconnaissance and study, we observed areas where levee and channel slopes have slightly steepened (generally waterside channel slopes) or flattened (landside levee slopes).

With the increased flood protection provided by the completed sections of the Llagas Creek Project, no flooding damages were reported from the floods of 1997, 1998, and 2008, within Reach 1, 2A, or 2B.

2.3 Existing Llagas Creek Channel and Levees

The existing Lower Llagas Creek Channel is composed of an open, partially excavated, heavily vegetated, earthen channel with vegetated earthen levees of varying heights constructed on both sides of the channel. Levee heights are generally 5 to 15 feet above the adjacent ground surface and 15 to 20 feet above the channel invert throughout the Project. In Reach 1 and Reach 2A (east levee, south of Station 108+00) levee heights are approximately 10 to 15 feet above the adjacent ground surface. In Reach 2A (east levee, north of Station 108+00) and Reach 2B South (east levee) levee heights are approximately 5 to 8 feet above the adjacent ground surface. In Reach 2B North, Reach 2B South (west side), and Reach 2A (west side, north of Station 108+00) the top of channel bank elevation is roughly the same as the existing ground surface (i.e. little to no levee features).

The levee crest ranges from approximate El. 155' (NAVD 88) at the downstream end to approximate El. 185' at the upstream end of the Project. There is an access along the channel, composed of dirt or graveled maintenance roads. Where present, the graveled surface of the maintenance roads was approximately 4 to 9 inches in thickness, as encountered during explorations. The typical levee crest width varies from approximately 15 to 20 feet, but is up to 30 to 80 feet wide along the eastern levee adjacent to the wastewater treatment evaporation ponds. Typical levee landside and waterside slopes range from approximately 2H:1V to 3H:1V. Waterside slopes within the channeled section of the Project range from approximately 2H:1V to 2.5H:1V.

Mature trees, bushes, brush, and annual grasses exist along the landside and waterside levee slopes and within the creek channel. A portion of the east levee crest, between approximate stations 50+00 and 108+00, is heavily vegetated with mature bushes, brush, and grasses, and is generally inaccessible to vehicular traffic. Within this segment, there is access along the landside toe of the levee, provided by an unimproved agricultural road within the adjacent agricultural property.

Within the excavated creek channel, dense vegetation exists along the waterside slopes and channel bottom. A narrow low-flow channel exists within the channel bottom, with invert elevations ranging from approximate El. 140’ at the downstream end to approximate El. 165’ at the upstream end of the Project. Five hydraulic grade control structures exist within the channel, located at approximate Stations 88+00, 110+00, 150+00, 163+00, 173+00, which are intended to control the hydraulic grade of creek flow throughout the Project reach. These structures are constructed of stacked rip-rap, approximately 12 to 36 inches in diameter, along the waterside channel slopes and bottom, extending approximately 300 to 400 feet along the length of the channel. The water level within the channel is influenced by flow from the upstream watershed including contributions from several agricultural drainage inlets and Miller Slough.

2.4 Other Pertinent Site Features

Several pertinent site features exist within the Project extents and are discussed below:

Adjacent Land Use: Areas adjacent to the landside of the levee are comprised of agricultural land, South County Regional Wastewater Authority (SCRWA) treatment facilities including evaporation ponds, an inactive landfill (discussed below), a firing range (discussed below) and industrial food processing facilities.

Agricultural Drainage Structures: Several agricultural drainage structures were observed within the Project extents during site visits and field exploration, which convey agricultural drainage from landside areas and discharge into the Llagas Creek channel. Typically, these structures consist of a concrete headwall intake structure near the landside toe of the levee, a reinforced concrete or corrugated metal pipe transecting through the levee prism, a sluice gate or valve control structure accessible on the crest of the levee, and an outlet structure with a flap gate discharge near the waterside toe of the levee. The number, locations, and details of these structures are outside of the scope of this project, but were noted where observed during site visits and on Project documents provided by the District in order to help plan the field exploration program. In most instances, dense vegetation along levee slopes and within the channel prevented detailed observations of these drainage structures.

Creek Flow Monitoring Stations: The USGS currently operates a creek flow monitoring station within the Llagas Creek Project extents, located on the west side of the creek at approximate Station 110+00, adjacent to one of the hydraulic dissipation structures. Where appropriate, available river stage data from this monitoring station was considered in Project evaluations and analyses. A second monitoring station is located on the west side of the creek at approximate Station 125+50, but is believed to be abandoned and non-operational.

Vehicular Bridges: There are three vehicular bridges that cross Llagas Creek within the Project extents; a two-lane bridge at Bloomfield Avenue, a one-lane maintenance access bridge at the eastern end of Southside Drive, used for SCRWA access between facilities located on either side of the creek, and a two-lane bridge at the Pacheco Pass Highway (CA 152).

Landfill: An inactive landfill exists along the western side of the creek, landside of the access road. The landfill is located between approximate Stations 109+00 and 121+00, and rises approximately 50 to 55 feet above the surrounding grade. Details of the landfill including age and type of landfill material were not provided to GEI and are outside of the scope of this study.

Firing Range: The Gilroy Police Department operates a firing range on the west side and adjacent to Llagas Creek, between approximate stations 122+00 and 126+00 (off Southside Drive). The range is fenced and the general firing direction is from north to south. It is located adjacent and to the north of the inactive landfill.

Observed Levee Cracks: Three areas of cracking of the levee fill material were observed along the levee crest during site visits and field explorations, located at approximate Stations 81+00 (east levee), 88+00 (west levee), and 97+00 (east levee). Cracks were typically oriented parallel to the levee alignment and up to 2-3 inches wide and 2-3 feet in length. These cracks appear to be associated with desiccation of the clayey levee fill material and not an indication of any local levee slope instability, settlement, or erosion. Similar cracks were observed and reported by the District during its Geotechnical Investigation of the Lower Llagas Creek Project, especially in Reach 1.

Reported Subsidence Area: During the field exploration program, the District reported that an adjacent property owner had recently observed subsidence on their property adjacent to the west bank of Llagas Creek. The District requested that a CPT exploration be relocated to provide subsurface information and data in the area of reported subsistence. To accommodate this request, a CPT exploration was relocated to approximate Station 166+75, on the west bank of the creek, in the vicinity of the reported subsidence area. Observations of subsidence features included minor cracking of pavement along the levee maintenance and access road.

Photographs of the noted pertinent site features, general creek, channel, and levee conditions, and exploration activities for the Lower Llagas Creek Project are included and annotated for reference in **Appendix A**.

3. Geologic Setting

3.1 Regional Geology

The Lower Llagas Creek Capacity Restoration Project (Project) extends from the Pacheco Pass Highway (CA 152) at its northern end to the confluence of Llagas Creek and the Pajaro River at its southern end, as shown in **Figure 1**.

The project is located in southern Santa Clara Valley, near the southern end of the greater San Francisco Bay area, in the Coast Ranges geomorphic province. This province owes its identity to the Pacific/North American plate margin that roughly parallels the Coast Ranges. The dominant northwest-southeast structural grain of the Coast Ranges is imparted by inactive and active faults associated with the plate margin. Active tectonism associated with fault bends and intersections is responsible for areas of uplift and subsidence, and these effects are reflected in the general vicinity of the project.

The Gabilan Range and Santa Cruz Mountains form the western flank of southern Santa Clara Valley, as shown in **Figure 2**. Rocks within the watershed encompassing the project are primarily metamorphic rocks of the Mesozoic-age Franciscan Complex, and overlying Tertiary marine and non-marine sedimentary rocks.

The Diablo Range forms the eastern flank of southern Santa Clara Valley. The dominant rock types within the Diablo Range are metamorphic rocks of the Franciscan Complex, Cretaceous-age sedimentary rocks, and lesser Tertiary-age sedimentary and volcanic rocks.

3.2 Local Geology

The Lower Llagas Creek Project lies along the alluvium-filled axis of the southernmost Santa Clara Valley, as shown in **Figures 2 and 3**. The valley is drained in the project vicinity by the southeastward-flowing Llagas Creek and tributaries to it. At the southern end of the project, Llagas Creek joins the Pajaro River. Their combined flow cuts southwestward through the Santa Cruz Mountains at Chittenden Gap (**see Figure 2**), thence to Monterey Bay.

The entire project lies within alluvial sediments of the Upper Llagas Subbasin (DWR, 1981). The total thickness of alluvial deposits overlying bedrock in the central Upper Llagas Subbasin is at least 450 feet (DWR (1981), cited in Mactec, 2006).

Sediment coarser than sand size that is transported by Llagas Creek is primarily lithic sediment derived from metamorphic and sedimentary sources (Wentworth and others, 1998; Graymer, 1997; Wagner and others, 2002).

Helley and Brabb (1971) mapped the alluvium of the valley floor as “Holocene Younger Alluvium” along Llagas Creek, with “Pleistocene Older Alluvium” lying to the east and west.

Dibblee (2005a-d) are posthumous reissues of 1970’s-vintage bedrock-focused geologic mapping. Dibblee’s bedrock-focused mapping show the project and valley floor areas in general as being underlain by Holocene “alluvial gravel, sand and clay of valley areas.”

Regional compilation geologic mapping by Wentworth and others (1998) includes approximately the very northernmost ¼ of the project area. Wentworth’s mapping shows the project as lying within Holocene levee deposits (map unit Qhl). Regionally, these are described as “sandy and clayey silt ranging to sandy and silty clay.” The Holocene levee deposits are mapped as flanked to the east and west by Holocene basin deposits (map unit Qhb), a finer-grained lateral equivalent of the levee deposits, typically “dark-colored clay and very fine silty clay, rich in organic material.” Both of these units are mapped as having blanketed the toes of older (upper Pleistocene) alluvial fans (map unit Qpf), described as generally “tan to reddish brown gravelly and clayey sand and clayey gravel, [grading] upward to sandy clay.” Wentworth and others interpret that the distribution of Holocene levee and basin deposits both reflect the locations of modern creek courses, while the older (Pleistocene) alluvial fan deposits may bear little or no relation to modern stream courses.

Regional compilation mapping by Graymer (1997) immediately flanks the mapping of Wentworth and others (1998) on the southern side, and includes the southern approximately ¾ of the project area. Graymer’s compilation shows the southern end of the project as lying within Holocene levee deposits (map unit Qhl) transitioning southward to Holocene “floodbasin” deposits (map unit Qhfp). Near the eastern end of Southside Drive, the project is shown as within levee deposits, with floodbasin deposits mapped closely to the west.

Knudsen and others (2000) prepared original Quaternary mapping and derivative liquefaction potential mapping for a nine-county area that includes the project. A regional Quaternary deposits map, including the Project Reach, is shown in **Figure 3**. Their mapping is consistent with the mapping of Wentworth and others (1998) and Graymer (1997) in that the northern part of the project (north of Southside Drive) is mapped as Holocene “alluvial fan levee deposits” (map unit Qhl), transitioning southward to Holocene “fine-grained alluvial fan levee deposits” (map unit Qhff). Knudsen and others (2000) is used as the basis for **Figure 3**, as it provides the most detailed, recent treatment of Quaternary deposits.

Wagner and others’ (2002) compilation mapping includes the same area mapped by Graymer (1997) – approximately the southern ¾ of the project. Wagner’s mapping shows the project as lying within undivided Quaternary “alluvium.” As shown on Graymer (1997), the project and the course of Llagas Creek are shown as flanked very close by to the west by “basin deposits” (map unit Qb) in the vicinity of Southside Road.

Mactec (2006, 2007) performed extensive subsurface exploration as part of a groundwater-focused investigation that assessed a perchlorate contamination plume extending from Morgan Hill down the Llagas Creek valley axis to near the confluence of Llagas Creek with the Pajaro River. While their focus was at deeper levels, their reconstruction of subsurface hydrogeology necessarily considered evolution of drainages and sediment supply to the Llagas Subbasin. The reader is referred to Appendix I of Mactec (2007) for a more complete examination of sedimentary facies (depositional environment and associated sediment types).

Within the uppermost approximately 200 feet of valley fill focused on, the dominant depositional setting for the Llagas Creek valley floor encompassing the project was interpreted by Mactec (2006, 2007) to be a frequently-shifting, meandering stream. In such a system, relatively thin and laterally extensive channel lag deposits with sharp erosive basal contacts transition upward and laterally to fine-grained levee and overbank/basin deposits. Volumetrically, the facies dominant ("Facies B") in cores examined by Mactec (2007) is "typically clast-supported, slightly cobbly sandy, fine to very coarse pebble gravel" inferred to represent channel deposits. Other distinguishable common facies included:

- Facies C - silty-sand to silt in intervals up to 10 feet thick with various ripple forms, and plant fragments;
- Facies D - silt to sandy silt with mud partings and plant fragments;
- Facies E – silt to sandy silt, notable for grayish green to olive green color with intervals of olive to creamy white clay, local shell fragments, and wood fragments;
- Facies F – moderately sorted, medium- to fine-grained sand, with variable ripple and stratification structures. This facies was described as rare, and less than 10 feet thick where encountered. It is interpreted as eolian in origin.

Mactec (2007) interprets Facies C, D, E, and F to represent well-vegetated floodplain settings adjacent to the channel deposits which make up Facies B. Changes in channel location are inferred to have occurred primarily through avulsion (rapid switching to a completely new course) during flooding, rather than lateral erosion and migration.

3.3 Regional Geomorphology

Major Creek Systems

Llagas Creek is a northern tributary to the Pajaro River (see **Figure 1**). The portion of southern Santa Clara Valley drained by Llagas Creek is known as the Llagas Subbasin (DWR, 1981). Major tributary creeks that contribute to Llagas Creek include its variously-named northern sub-branches (West Branch of Llagas Creek, East Little Llagas Creek), San Martin Creek, New Creek, Church Creek, Rucker Creek, Skillet Creek, and Live Oak Creek (names as shown on Sowers and Henkle, 2009). Uvas Creek (also known as Uvas-Carnadero Creek) joins the Pajaro River approximately 2.5 miles southwest of the Llagas/Pajaro confluence, and therefore does not flow through the project. The Llagas Creek watershed totals approximately 90 square miles.

The approximately 1300-square-mile Pajaro River watershed collects flow and sediment from several tributary creeks that drain watersheds generally southeast and east of the Llagas Creek/Pajaro River confluence.

The confluence of Llagas Creek with the Pajaro River lies within a broad, poorly drained alluvial basin known as Soap Lake. The historic extents of the Soap Lake Floodplain are depicted in **Figure 4**. Historically, Soap Lake or portions of it have been known as San Felipe Lake, and the "Bolsa" (Spanish for "pocket"). The confluence of Uvas Creek with the Pajaro River lies within the maximum extent of Soap Lake (Grossinger et al., 2008).

Historic Geomorphology

Llagas Creek flows southward into the project area from the Morgan Hill and San Martin area. At present, there are no large creek/alluvial fan systems directly feeding the project area. At times in the geologic past, there may have been at least two such systems supplying coarser sediment than today's creek and watershed geometry would suggest: Uvas Creek, and Coyote Creek. The headwaters of Uvas Creek in Pleistocene time may have flowed into the upper Llagas Creek watershed until cut off and diverted into today's Uvas drainage by late Pleistocene uplift (McLaughlin and others, 2000). Apart from Llagas Creek, the largest of the creeks draining the western slopes of the valley is Uvas Creek, which currently joins the Pajaro River downstream of the project's southern boundary. At times in the past, however, it likely flowed along a more northerly path and joined Llagas Creek before the Llagas/Pajaro confluence, near the very southernmost end of the project. Coyote Creek generated a large, coarse alluvial fan centered at the latitude of Morgan Hill that in Pleistocene times fed sediment into the upper reaches of Llagas Creek. Both of these fans (Uvas and Coyote Creek) generated coarse deposits in the deeper sedimentary record beneath at least the northern end of the project alignment (Mactec, 2007), although neither of these supplies sediment to Llagas Creek today. The watersheds of Coyote Lake and Anderson Lake were captured by the Coyote Creek drainage at some point in the geologic past; before that drainage capture event, they likely flowed into the project area. A dissected, alluvial fan on today's Church Creek is a relict of the time when the Coyote Lake watershed drained westward into the project area.

Ongoing tectonic deformation affects the drainage patterns and creek behavior throughout the valley floor, and the drainage networks are still responding to that deformation. Bedrock uplift and folding within the Santa Cruz Mountains (McLaughlin and others, 2000), together with the westward overall tilt of the valley floor, have tended to force Llagas Creek westward against the range front in reaches north of the project (i.e. Morgan Hill and San Martin vicinity), where it skirts the eastern ends of plunging bedrock fold hinges.

The Llagas Creek/Pajaro River system is not smoothly graded to sea level. Effective base level for Upper Llagas Subbasin and Pajaro River is set by Chittenden Gap (see **Figure 1**), where the Pajaro River crosses the San Andreas Fault. The base level established by Chittenden Gap has led to deposition of a thick, relatively fine-grained alluvial sequence near the Llagas/Pajaro confluence, extending southeast toward Hollister. These sediments were interpreted by early workers (Jenkins, 1973) as Pleistocene lake bed deposits ("Lake San Benito"), although subsequent detailed work (Hoose, 1986) established that no persistent lake occupied the valley floor. Mactec's (2006, 2007) synthesis of subsurface data further confirms that the fine-grained deposits are not consistent with persistent lakes.

Soap Lake

While persistent lakes may not have been present, flow from two major drainage basins currently converge near the southern end of the project: the Llagas Creek (Llagas Subbasin) and the Pajaro River/San Benito River (see **Figure 4**). The valley floor in the vicinity of this confluence has, over time, supported several poorly drained, ephemeral lakes, variously given the names Soap Lake, San Felipe Lake, Pajaro Lake, and the Bolsa (Spanish for "pocket").

The name Soap Lake is perhaps best most consistently applied in modern times to the area affected by flooding near the Llagas/Pajaro confluence. **Figure 4** shows the approximate 100-year floodplain of Soap Lake (RMC, 2005).

Historic (1858) maps show a "Pajaro Lake" located near the lower end of Llagas Creek, essentially within the modern Soap Lake 100-year floodplain (Grossinger et al., 2008). The limit of this lake, transferred to modern base maps, is shown on **Figure 4**.

San Felipe Lake (also shown on **Figure 4**) persists to the current day. Historic maps reproduced in the San Francisco Estuary Institute (SFEI) 2008 South Santa Clara Valley Historical Ecology Study (Grossinger et al., 2008) record a dwindling of the lake's size from a maximum documented extent in 1839, leaving sinuous sloughs and channels to the east of the area currently generally below water today. San Felipe Lake also lies within the Soap Lake 100-year floodplain.

The "Bolsa" refers in general to the poorly drained low ground near the Llagas/Pajaro confluence, corresponding roughly to the west-central portion of the Soap Lake 100-year flood plain.

Upstream of Soap Lake along Llagas Creek, the floodbasins to either side of Llagas Creek's natural levees in historic times supported freshwater marshland and/or willow groves along virtually the entire length of the project (Sowers and Henkle, 2009; Grossinger et al., 2008; see) as did Uvas-Carnadero Creek (Grossinger et al., 2008). **Figure 5** shows the Historic Creek Geomorphology map of the Lower Llagas Creek vicinity and Project Reach.

Llagas Creek Historic Morphology

The modification of Llagas Creek has somewhat obscured its historic character, as documented in historic photographs (Grossinger et al., 2008; see **Figure 6**). Individual channels, in an unmodified condition, tended to be shallow and wide, with relatively flat floors. As reconstructed by Mactec (2007), these channels tended to migrate laterally through avulsion (sudden switching during a flood event) rather than gradual lateral migration. As a result, buried channel deposits tend to be more locally discrete bodies than laterally extensive coarse blankets.

Before the influence of settlers, agriculture, and flood-control efforts, Llagas Creek had many meanders that have since been obscured by grading and channelization. **Figure 6** (excerpted from Grossinger et al., 2008) is an example. These cut-off and buried meanders likely contain lenses of sandy and gravelly channel deposits; encompassed within generally more laterally extensive, fine-grained flood basin deposits.

3.4 Regional Groundwater

Groundwater in the project area is managed by the Santa Clara Valley Water District (SCVWD). Groundwater in the project area has an overall southward flow (DWR, 1981; Mactec, 2006, 2007). The project is located within the Llagas Subbasin, which is part of the Gilroy-Hollister Groundwater Basin.

The Tertiary and Mesozoic rocks that form the Gabilan Range, Santa Cruz Mountains and Diablo Ranger are relatively impermeable in comparison to the alluvial fill of the valley occupied by Llagas Creek and its tributaries.

As summarized in Mactec (2006), SCVWD (1989) considered the project vicinity to consist of three hydrostratigraphic units: an unconfined aquifer comprising the edges and northern limit of the basin, and two confined aquifers separated by a 40- to 100-foot-thick aquitard. The depth to the aquitard was considered to vary from about 20 to 100 feet below ground surface. The lower aquifer consists of poorly dated Pliocene- to Pleistocene-age sediments.

Mactec's (2007) analysis of new and existing subsurface information identified three aquifers in the portion of the valley north of, and just inside, the project area: a shallow aquifer (from zero to about 100 feet below ground surface [bgs]); an intermediate aquifer (from about 100 bgs to about 220 feet bgs; and a deep aquifer (below 220 feet bgs). Laterally extensive lake-bed deposits are not present, based on sedimentary cores (Mactec, 2007).

Depth to groundwater in the Project vicinity is generally shallow. Potentiometric contours at the latitude of Gilman Avenue (just north of the project area) show a potentiometric surface at approximate elevation 160 ft (above mean sea level), or approximately 20 feet bgs

(Mactec, 2007). This generally agrees with observations of groundwater levels encountered during the exploration program (see *Section 4.3* for more detail).

3.5 Faulting and Seismic Considerations

No surface expression of faulting is mapped as passing through the project alignment (Hart and Bryant, 2007; Jennings and Bryant, 2010), and fault ground rupture is not considered to be a concern to this project.

Due to the project's location in the seismically active San Francisco Bay Area, the project area has experienced significant earthquake ground shaking from multiple seismic sources. The two seismic sources most pertinent to the project are the Calaveras fault and the San Andreas Fault, with other seismic sources contributing to seismic hazard to a lesser extent. A Regional Fault Map, including the Project Area, is shown in **Figure 7**.

The Santa Cruz Mountains segment of the active San Andreas fault is located approximately 7.6 mi (12.2 km) southwest of the project (USGS Fault and Fold Database at http://earthquake.usgs.gov/hazards/qfaults/ accessed 2/8/12). The San Andreas fault has experienced at least four damaging, large earthquakes during historic time: 1838, 1857, 1906, and 1989. Surface fault rupture associated with the 1838 and 1906 events (moment magnitude [Mw] 6.8 and 7.9, respectively) included the Santa Cruz Mountains segment and extended as far south as San Juan Bautista, approximately 9.0 mi (14.5 km) south of the project. South of that point, the San Andreas fault is undergoing creep.

The active Calaveras fault is located approximately 2.2 mi (3.5 km) northeast of the project (USGS Fault and Fold Database at http://earthquake.usgs.gov/hazards/qfaults/ accessed 2/8/12). The segment of the Calaveras closest to the project is the central segment, which runs parallel to the Santa Clara Valley axis, in the lower hillslopes east of the project; the site is nearest the southern end of this segment. The transition from the central to the creeping southern segment of the Calaveras fault occurs approximately at the point where the fault leaves the hillslopes and drops onto the valley floor at San Felipe Lake.

Other seismic sources at greater distances from the project, and of lesser concern to the project, include the San Gregorio-Hosgri fault (at the mouth of Monterey Bay, 37 mi (60 km) southwest of the project), and the Hayward fault (35 mi (57 km) northwest of the project), as shown in **Figure 7**. The Sargent fault, while there is evidence for creep (Prescott and Burford, 1976) and sympathetic rupture during the 1989 earthquake (Aydin and others, 1992) along it, is no longer included in the CGS probabilistic fault model for California (WGCEP, 2003; WGCEP, 2008). The Sargent fault lies about 3.7 mi (5.9 km) southwest of the project.

The USGS Working Group on California Earthquake Probabilities has developed probabilistic models for major faults in the greater San Francisco Bay area. Now in at least the third iteration, these models indicate that there is a 63 percent chance of a "major" earthquake (magnitude greater than or equal to Mw 6.7) striking the San Francisco Bay Area in the 30-year period ending 2037 (WGCEP, 2008). Breaking out probabilities on individual faults, WGCEP (2003) estimated that the probability of a major earthquake on the Calaveras fault is 11% for the 30-year period ending 2031, and 21% for the San Andreas fault as a whole.

3.6 Liquefaction Considerations

The most detailed and recent published regional geohazard mapping encompassing the site is the Quaternary geologic and liquefaction susceptibility mapping performed by Knudsen and others (2000). Quaternary deposits in the project are shown on **Figure 3**, and the derivative liquefaction susceptibility mapping is shown on **Figure 8**. Knudsen's mapping classifies the "alluvial fan levee deposits" that underlie the project from approximately Southside Drive northward as having a "moderate" liquefaction susceptibility (second-highest class in a five-class spectrum), and the "fine-grained alluvial fan levee deposits" underlying the southern remainder of the project as having a "high" liquefaction susceptibility.

The California Geological Survey (CGS) has not yet prepared a Seismic Hazard Zone quadrangle map encompassing any portion of the project area. This series of maps establishes zones for which the potential for liquefaction and earthquake-induced landsliding must be addressed for certain classes of project.

The County of Santa Clara has established its own series of hazard zone maps that consider a variety of hazards. The County's hazard mapping in general shows Llagas Creek north of Southside Drive as lying within a ribbon of ground flanked on either side by "liquefaction hazard zones." South of that point, the remainder of the project lies within a liquefaction hazard zone (County of Santa Clara, rev. 2007 and subsequent web updates, accessed at www.sccgov.org on 2/8/12). Portions of the project are mapped as lying within a "compressible soil hazard zone," most notably a segment extending northward from approximately 1,000 feet north of Bloomfield Avenue, nearly to Southside Road. The project does not lie within a fault hazard zone or dike failure inundation zone. The County's 2002 hazard mapping supersedes earlier County hazard mapping (Rogers and Williams, 1974).

Further discussion and detailed analysis of seismic and liquefaction potential are presented in *Section 5* of this report.

4. Field Exploration and Laboratory Testing

4.1 Field Explorations

A field exploration program was performed to evaluate and characterize subsurface conditions within the Lower Llagas Creek Project. The exploration program was based on the results of review of available geologic, geotechnical, and geomorphic information and existing site conditions assessed during previous site visits. The field exploration program was completed using cone penetration tests (CPT), rotary wash borings, and hollow-stem borings performed along the existing levee alignment on both sides of the creek. CPTs were used predominantly and spaced at approximate 600 to 1000-foot intervals along each side of the creek. Rotary wash and hollow-stem borings were spaced at approximate 700 to 2700-foot intervals along each side of the creek, with the largest spacing intervals occurring along the vegetated portion of the east levee where vehicle access was limited or completely inaccessible. Nine borings were paired with CPT locations and used to calibrate the results obtained from the CPTs. Additionally, two stand-pipe piezometers were installed within the Project area, to allow for future groundwater monitoring by the District. The approximate locations of all field explorations performed and installed piezometers are shown on **Figures 9a through 9e** and summarized in **Table 1**.

The field exploration program was performed in two phases at the site. Phase 1 included CPTs along the levee crest and channel from December 12, 2011 through January 11, 2012. Phase 2 included rotary wash and hollow-stem borings along the levee crest, the top of the channel bank, and one landside toe location from January 3-13, 2012. All CPTs were performed by CPT Inc. of Menlo Park, CA. All rotary wash and hollow-stem borings were performed by Exploration Geoservices of San Jose, CA. CE&G, PGE, and GEI field representatives were on site to coordinate and direct all subsurface exploration activities and piezometer installations, log the borings in general accordance with ASTM D2488, and recover representative soil samples of the subsurface materials.

Phase 1 of the field investigation program included 28 CPTs; all performed along the levee crest. CPTs were advanced to depths between 25 and 65 feet below existing ground surface by a track-mounted rig. Final locations and soil sampling intervals for the Phase 2 borings were established based on an initial review of the CPT results.

Phase 2 of the field investigation program included 15 rotary wash and/or hollow-stem borings. Fourteen borings were performed along the levee crest or channel. Due to access issues, one boring was performed at the landside toe of the levee. Borings were drilled to depths between 40 and 65 feet below existing ground surface using a truck-mounted rotary wash or hollow-stem drilling set-up.

4.2 Exploration Methods and Details

CPTs were performed by CPT Inc. under the direction of GEI, CEG, and/or PGE, using a Geoprobe Model 6625CPT rig, a limited-access, self-anchoring, 20-ton push capacity, track-mounted push platform. Geoprobe 6625CPT incorporates the Swedish-made Geotech AB Cone Penetration Testing tools which meet the ASTM D5778 Standard Test Method for Performing Electronic Friction Cone and Piezocone Penetration Testing of Soils. The cones have 10 cm^2 tips and 150 cm^2 friction sleeves and include a porous filter and pressure sensor. The cone and porous filter are saturated under vacuum with glycerin to promote rapid equilibration with in-situ pore pressures. Cones are advanced at the ASTM standard rate of two cm/sec. Baseline readings are performed both before and after each push to measure temperature and load cell drift. The cone measures bearing, sleeve friction, and dynamic pore pressure at two centimeter intervals and this data is plotted in real time and recorded on a laptop computer adjacent to the push platform. Plots of soil behavior type (SBT), tip resistance (q_c), friction (f_s), pore pressure (u), undrained shear strength (S_u), and SPT N_{60} energy ratio are calculated and/or interpreted by CPT-Pro software based on algorithms presented in Robertson et al. (1986), Robertson (1990), and Lunne et al. (1997). The CPT data files were provided to GEI by CPT Inc. and used in project analyses.

Rotary wash and hollow-stem borings were performed by Exploration Geoservices under the direction of GEI and CEG using a truck-mounted drill rig equipped with a 4.5-inch-diameter rotary wash drill or 6-inch diameter hollow-stem auger. The borings were logged in the field by CEG personnel. During the drilling operations, soil samples were obtained using one of the following sampling methods:

- California Modified (CM) Sampler; 3.0-inch outer diameter (O.D.), 2.5-inch inner diameter (I.D.)
- Standard Penetration Test (SPT) Split Spoon Sampler; 2.0-inch O.D, 1.375-inch I.D.
- Thin-walled Shelby Tube; 3.0-inch O.D.
- Bulk samples; 5-gallon bucket

Except for the Shelby Tubes, the samplers were driven 18 inches (unless otherwise noted) into undisturbed soil using a 30-inch drop of a 140-pound calibrated automatic trip hammer. The number of blows required to drive the SPT and CM sampler 6 inches was recorded for each sample and included on the boring logs. The Shelby Tube sampler was pushed to within a few inches of the tube length (generally 36 inches) into the underlying soil in order to obtain a relatively undisturbed sample. Some sampling runs were terminated when resistance from the soil was sufficient to reach a limiting pressure selected by the driller to avoid damage to the tube and/or sampler. The required pressure to push the Shelby Tube was recorded on the field logs. Bulk samples of the levee fill material were collected from the auger cuttings during drilling and contained in 5-gallon buckets sealed with lids. Soil samples obtained from the borings were packaged and sealed in the field to reduce moisture loss and disturbance and transported to PGE's Gilroy office for temporary storage prior to review and laboratory testing.

Drilling equipment including augers, samplers, and rods were steam cleaned following the completion of each boring or sampling interval, as appropriate. Steam cleaning procedures were observed and directed by Eric Lautenbach, of Light, Air, and Space, a sub-consultant to the District contracted to perform environmental sampling and testing for District purposes. Fluids generated from steam cleaning procedures were collected and contained in 55-gallon drums. The District's environmental sub-consultant also collected select soil samples for additional testing purposes from material recovered from the borings.

Soil cuttings from rotary wash and hollow-stem borings were contained in 55-gallon drums and temporarily stored on-site, within District property at a pre-selected location. Samples of the soil cuttings were collected and delivered to an approved laboratory for environmental testing of the soil material. Following the completion of environmental testing, the drums containing soils cuttings were removed from the site and properly disposed of in accordance with state, federal, and local regulations. Fluids generated from steam cleaning of the drilling equipment were also drummed and stored on site at the same pre-selected location. Testing and disposal of these fluids was performed by the District and not included in this Project scope. All exploration boreholes were grouted to the surface with neat cement grout upon completion of the investigation under the supervision or verbal approval of a representative of the Santa Clara Valley Water District. Additional details regarding the field exploration program and the logs of the CPT and boring explorations are included in **Appendix B**. Photographs of field exploration activities are included in **Appendix A**.

4.3 General Subsurface Conditions

The field explorations encountered artificial fill and alluvial soils. In general, the subsurface conditions consist of levee fill material overlying alluvial deposits which extend to the depth of the explorations. These alluvial deposits are composed primarily of medium stiff to stiff lean and fat clay, peat and organic soils, silt mixtures, and medium dense to dense sand and gravel mixtures at depth.

Artificial Fill

Levee fill ranged in thickness from approximately 6 to 18 feet and is composed generally of stiff fat clay, with isolated lenses of sandy silt and silty sand. Other artificial fill encountered during exploration included maintenance and access roadway material (crushed gravel or aggregate road base) and silt and clay mixtures.

Upper Alluvial deposits

The uppermost alluvial deposits encountered are generally clayey. The thickness of this clayey upper interval tends to deepen from north to south, with the base of the clayey interval deepening from about 20 to 25 feet bgs near the north end of the project, to about 39 to 44 feet near the southern end.

Sand and gravel lenses were encountered within the uppermost alluvial deposits in the near surface (i.e. within 10 feet), especially in the northern portion of Reach 2A and throughout Reach 2B. These deposits, where encountered, consisted of loose to dense sand with silt and gravel and silty sand, ranging from 6 inches to 4 feet in thickness. These sandy layers are interpreted to be deposits from historic meanders of Llagas Creek before it was engineered and channelized in its current alignment. Study of historical ecology in this area indicate that Llagas creek exhibited a braided channel morphology in portions of the Project area, north of the historic Soap Lake Basin (Grossinger et al., 2008), which is consistent with these deposits (see discussion in *Section 3.3*).

Organic deposits, composed of peat and highly plastic fine-grained material with organics, were encountered in explorations performed south of approximate Station 92+50 within the shallow levee foundation. These deposits, where encountered, are approximately 6 to 18 inches in thickness and located at a depth of approximately 20 to 25 feet below the levee crest (approximately 5 to 10 feet below the adjacent ground surface). Typically, the peat material was dark in color, slightly odorous, and generally associated with softer fat clay materials of the alluvial deposits. These observations are consistent with previous geotechnical explorations performed by others in this area, showing similar extents, thickness, and composition of the organic deposits. These fine-grained and organic materials are interpreted to be deposits from the historic Soap Lake Basin and Pajaro Lake, located in the general vicinity of the southern portion of Reach 2A and Reach 1 of Llagas Creek, north of the confluence with the Pajaro River. Seasonally, the area would flood in the wet months before draining out through the Pajaro River, depositing fine-grained material along with organic debris in this marshy lowland area (see *Section 3.3* and **Figure 4**).

Deeper Alluvial Deposits

Thicker deposits of coarse grained material including medium dense to very dense sands and gravel mixtures were encountered at depth throughout the Project area. These deposits ranged in thickness from 5 to 25 feet, tend to be laterally discontinuous with no clear depth or thickness trends within the project area, and are interpreted to be a portion of the underlying Llagas Subbasin shallow aquifer.

Groundwater

During the subsurface exploration program, groundwater was encountered between elevation 130 and 161 feet, or approximately 18 to 25 feet below ground surface (approximately 10 to 20 feet below surrounding landside ground surface, away from levee or berm features); typically within a few feet of the channel invert elevation and the approximate elevation of creek flow within the channel. South of approximate Station 92+50, however, groundwater was encountered between 5 and 8 feet below the channel invert elevation, within the fine-grained and organic materials interpreted to be deposits from the historic Soap Lake Basin. These observations are consistent groundwater trends reported in the Project Vicinity by others (DWR, 1981; Mactec, 2007).

Groundwater was observed and recorded at the time of drilling in all but three of the boring locations. Borings B-65+00E, B-92+50E, and B-148+00E were drilled with rotary wash drilling methods during exploration. Due to the set-up of the rotary wash drill rig for borings through the levee crest, it was not possible to obtain groundwater measurements at these locations. Groundwater levels, where observed during drilling, are recorded for reference on each boring log (see **Appendix B**).

4.4 Laboratory Testing

Laboratory tests were performed on selected samples to aid in classification of the soils encountered at the site and to estimate strength parameters and material properties for use in engineering analyses. Classification tests included moisture content and unit weight determinations, Atterberg limits, grain size distribution, fines content and organic content. Tests performed to estimate strength parameters and material properties included compaction characteristics, consolidation, unconfined compression, triaxial unconsolidated undrained, triaxial consolidated undrained, and permeability tests. Geotechnical laboratory testing was performed by Cooper Testing Laboratory of Palo Alto, California. The type and quantity of tests are summarized in the table below:

Geotechnical Laboratory Test Summary			
Test Type	**ASTM**	**Quantity**	**Purpose**
Moisture Content	D2216	18	In-place moisture content
Moisture-Density	D2937	31	In-place moisture content and density
Atterberg Limits	D4318, Method B	35	Evaluate liquid and plastic limits
Grain Size Distribution	D422	26	Determine gravel, sand and fines content
-200 Wash (% passing #200 sieve)	D1140	12	Determine fines content
Organic Content	D2974-00, Method C	3	Determine organic content
Unconfined Compression	D2166	18	Estimate soil strength parameters
Triaxial Unconsolidated Undrained	D2850	15	Estimate undrained shear strength
Triaxial Consolidated Undrained	D4767	4	Estimate soil strength parameters
Consolidation	D2435	5	Estimate soil settlement properties
Compaction Test	D698, Method B	1	Estimate maximum soil density and optimum moisture content
Hydraulic Conductivity	D5084	1	Estimate soil permeability

Results of laboratory tests are presented at the corresponding sample locations on the boring logs. An overall summary of geotechnical subsurface data collected during the field exploration program is provided in **Table 3**. The laboratory test reports provided by Cooper Testing Laboratory are included in **Appendix C.**

In addition, environmental testing was performed on composite samples from the drummed soil cuttings generated during drilling activities. Environmental tests were performed to detect the presence of pesticides, hydrocarbons, and Title 22 metals. The results of these tests were used to aid in proper disposal of the soil cuttings. Environmental testing was performed by Curtis & Tompkins Laboratories of Berkeley, California. The type and quantity of tests are summarized in the table below:

Environmental Laboratory Test Summary			
Test Type	**EPA**	**Quantity**	**Purpose**
TPHG/MTBE/BTEX	8015B	15	Detect hydrocarbons
Diesel and Motor Oil	8015B	15	Detect diesel and motor oil
Organochlorine Pesticides	8081B	15	Detect pesticides
California Title 22 Metals TTLC	6010B	15	Detect Title 22 Metals Total threshold limit concentration
California Title 22 Metals Chromium (STLC)	6010B	12	Detect Title 22 Metals Soluble threshold limit concentration

A summary table of the environmental sampling laboratory data from testing performed by Curtis & Tompkins Laboratories is included in **Appendix C,** along with the individual laboratory test reports**.** Manifest certificates documenting proper disposal of soil cuttings are also included in **Appendix C**.

4.5 Standpipe Piezometer Installation

Our scope of work also included the installation of two stand-pipe piezometers within the Project area for use by the District for long-term ground water monitoring in the project area. Standpipe piezometers P-132+50E and P-173+50W were installed on March 29, 2012, adjacent to previous borings B-132+50E and B-173+50W, respectively. The wells were sited within a few feet of these borings to permit using the stratigraphy encountered and logged in those borings to select the piezometer screen interval. The wells were located a few feet off of the graveled maintenance roadway to minimize disturbance of the well by vehicular traffic.

P-132+50E was installed on the water (channel) side of the levee crest. P-173+50W was installed on the land side of the levee crest due to extensive riprap placed at a drop structure with access ramps which had previously presented refusal to CPT exploration on the water (channel) side. Piezometer installations were performed by Exploration Geoservices of San Jose, CA using a truck-mounted hollow-stem drilling set-up. Piezometer installations were directed and observed by G. Reid Fisher (CEG) of Pacific Geotechnical Engineering. The approximate locations the installed piezometers are shown on **Figures 9a through 9e** and summarized in **Table 1**.

Piezometer P-132+50E was permitted through the SCVWD under District Permit No. 12W00109, and Piezometer P-173+50W was permitted under District Permit No. 12W00110. Construction details and procedure for both piezometers were identical. Hollow-stem augers with an outside diameter of 8 inches were used to drill to a total depth of 40.0 feet. Two-inch-diameter, Schedule 40 PVC casing was fitted with a solid spear point tip, using a threaded, O-ring joint. From bottom to top, the casing tip was followed by twenty feet of screened casing (0.010” slot size), and twenty feet of solid pipe, again using threaded joints. Approximately 8 inches of solid pipe was cut from the upper end (to provide clearance above the top of casing within the well vault). A locking expansion plug was installed on the top of the casing, and a padlock fitted.

The annulus was filled to a depth of 18 feet below ground surface (two feet above the top of the screened interval) with Monterey #3 sand, and the depth to top of sand measured.

Using a stainless steel surge block on a nylon line, the driller raised and lowered the surge block in approximately 3-foot depth intervals, for approximately 15 minutes. Using a plastic bailer, the well was then bailed, and a decrease in turbidity noted. The depth to top of sand was then rechecked, and the sand topped up to a depth of 18 feet below ground surface.

Three feet of bentonite chips were then placed in the annulus, and water added to permit hydration. After hydration, the annulus was filled with neat cement (Portland Type I/II) under inspection provided by the SCVWD. A cylindrical steel, flush-mounted well cover/vault was then installed, and concrete used to create a smooth surrounding surface extending a few inches from the lip of the vault. Upon completion, the padlocks were locked, and the well covers closed. The as-constructed details of the installed stand-pipe piezometers are included in **Appendix D**. Photographs of piezometer installation activities are included in **Appendix A**.

5. Engineering Analyses

Section 5 provides descriptions of the engineering analyses conducted to evaluate the geotechnical aspects of the existing Lower Llagas Creek levees and channel slopes within the identified evaluation reach, and a summary of the engineering analyses results. We understand that the results of these analyses will be used to assist the District in its assessment of the feasibility of various alternative design concepts to improve flood protection and capacity restoration. The geotechnical engineering analyses of existing conditions include:

- Steady-state seepage (under-seepage and through-seepage)
- Steady-state seepage slope stability
- Rapid draw-down slope stability
- Seismic analyses (liquefaction and post-seismic stability)
- Settlement evaluation (based on potential levee raise with engineered fill), and
- End-of-construction stability

The criteria (maximum gradient, minimum factor of safety) considered acceptable for in respect to these analyses were adopted from the following references.

- USACE Engineer Manual EM 1110-2-1913, Design and Construction of Levees, dated April 30, 2000.
- USACE Engineer Manual EM 1110-2-1902, Slope Stability dated October 31, 2003.
- Title 44 Code of Federal Regulations 65.10: Mapping of Areas protected by Levee Systems.

Specific criteria referenced for each analysis are described further in the following sections.

5.1 Design Water Surface Profile

As discussed in *Section 2.1* the District is evaluating the existing channel in regard to providing 100, 50, 25, or 10-year flood protection, depending on the area of the channel. (Generally the level of protection decreases as progression is made downstream along Lower Llagas Creek). A design water surface elevation (WSE) was provided by the District for use in Project analyses including steady-state seepage analyses and steady-state seepage stability and rapid drawdown stability analyses. The Project design flow rates and WSE, top of levee and channel, creek invert, and required minimum freeboard profile, are shown in **Figure 10** for ready reference. This information is also presented in tabular format in **Table 2**. GEI assumed a typical winter WSE within the channel and an assumed ground water elevation in the vicinity of the levee prism for rapid draw-down, post-seismic stability and end-of-construction analyses. The typical winter WSE was based on observations during Project site visits and limited Llagas Creek stage data recorded at the USGS monitoring station within the Project extents. The assumed groundwater elevation was based groundwater data collected from the installed piezometers, P-135+50E and P-173+50W, and groundwater levels observed during the subsurface exploration program.

5.2 Subsurface Profile and Analysis Cross-Sections

A subsurface profile was developed along the existing Llagas Creek levee and channel alignment to aid in subsurface characterization and Project analyses. **Figures 11-14** show exploration profiles along the evaluation reach. The profile includes plots of the existing ground surface elevation along the levee crests and toe, the channel invert, the design flood WSE, and interpreted results of boring and CPT explorations.

Seven representative cross sections were established for engineering analyses, located at Stations 50+00, 78+00, 92+50, 106+50, 126+00, 134+00, and 166+50. These cross sections were located in areas where sufficient subsurface data was available and that we judge to represent the more critical surface and subsurface conditions at the site (in terms of levee stability and under-seepage), including areas with relatively soft underlying fine-grained and organic material, areas with thicker or shallow pervious soil strata, and areas with steeper levee slopes. The analysis cross sections are shown on **Figures 15-21**, and include cross-section topography and interpreted results of nearby boring and CPT explorations. Where available, subsurface data and information from previous explorations by others within the Llagas Creek Project area was used to supplement the subsurface data collected by the GEI team during the field exploration program, fill any data gaps between recent explorations, and confirm or refine the stratigraphy developed at each analysis cross section. A summary of the subsurface information from previous explorations considered in evaluations is provided for reference in **Appendix B**.

5.3 Existing Conditions Steady-State Seepage Analyses

5.3.1 *Analysis Approach*

Existing conditions steady state seepage analyses were performed for 5 cross-section locations along Reaches 1 and 2A where levees were present along Llagas Creek. With the exception of Station 166+50, levees on both the eastern and western banks of the creek were evaluated for a given cross section location. Section 126+00 West, and the Sections in Reach 2B at Station 134+00 and 166+50 were not evaluated in SEEP/W for underseepage potential, because these locations are located in channelized creek areas (i.e. a levee underseepage issue is not present). However, the SEEP/W analyses were used to develop steady-state pore pressures for evaluation of waterside rapid drawdown stability in these channelized areas as described in *Section 5.4* of this report.

The objectives for the seepage analyses included:

- Assessing seepage flow mechanisms and characteristics for selected cross-sections.
- Estimating phreatic surfaces within the levee prism.
- Estimating pressure distributions within the levee prism and foundation

Seepage analyses were conducted in general accordance with USACE Engineer Manual EM 1110-2-1913. The seepage analyses results were compared to established USACE criteria. As specified in EM 1110-2-1913 the maximum allowable exit gradient estimated at the landside levee toe is 0.5.

The seepage evaluations were performed using finite element analyses using 2007 SEEP/W software, developed by GEO-SLOPE International, Ltd. Total head estimates from SEEP/W analyses were used to estimate average vertical exit gradients at landside levee toe areas and the phreatic surface within the levee prism. Pore pressure distributions from SEEP/W were used in slope stability analyses as described in *Section 5.4* of this report.

5.3.2 *Design Hydraulic Conductivity Parameters*

Material properties assigned to each identified soil layer within the seepage models were selected using the results and data from the subsurface exploration program and laboratory testing, review of relevant literature and published ranges of values for different soil types, empirical correlation of grain size to permeabilities (for sand and gravel materials), available hydraulic conductivity test data (for embankment fill materials), and previous experience from similar evaluations. These properties included soil permeability and anisotropy values. Seepage analyses material properties for each of the analysis cross-sections are summarized in **Appendix E**.

5.3.3 *Seepage Evaluation and Results*

The results from seepage analyses indicate that for the 5 analysis cross-sections, the estimated average vertical exit gradient (i) ranged from less than 0.1 to 0.6 at the levee toe. The average vertical exit gradient at the landside levee toe exceeded the USACE maximum criterion (i = 0.5) at Section 106+50 (east and west levee), due to the thin low permeability blanket materials and more elevated coarse grained alluvial layers beneath the levee prism and levee toe at this Section. The estimated average vertical exit gradient was less than USACE underseepage criteria (i.e. acceptable) for the other three sections that were analyzed. It is noted that the average vertical exit gradient estimated at Section 126+00 (east levee only) is considered marginal (0.48). Due to the relatively impervious nature of the clayey embankment fill materials, through-seepage is not anticipated to be a deficiency for the evaluated Reaches of Llagas Creek.

Results of seepage analyses, including the estimated average vertical exit gradient (i) and the corresponding factor of safety (FS) against development of seeps and sand boils are summarized in **Table 4**. A more comprehensive discussion of all Project seepage analyses and results including approach, material properties, boundary conditions, and SEEP/W output figures are presented in **Appendix E**. It should be noted that no assessment was made as to the potential for seepage paths to exist within the embankment due to the observed large vegetation, nor was seepage potential due to vegetation represented in the analytical models developed for this evaluation.

5.4 Existing Conditions Slope Stability Analyses

5.4.1 *Analyses Approach*

Existing conditions stability analyses were performed at the analyses cross-section locations selected within the Lower Llagas Creek study area. Analyses were conducted in general accordance with USACE Engineer Manual EM 1110-2-1913 and USACE Engineer Manual EM 1110-2-1902. Existing conditions slope stability was analyzed for two applicable design cases:

- **Case 1** – Steady State Seepage Stability
- **Case 2** – Rapid Drawdown

The stability evaluations were performed using finite element analyses using 2007 SLOPE/W software, developed by GEO-SLOPE International, Ltd. Levee stability for each case was evaluated using the appropriate piezometric conditions and corresponding soil strength properties. Stability was evaluated using the Morgenstern and Price analysis method, which satisfies both moment and force equilibrium. Slip surfaces were defined using the grid and radius method. The approach for each case is summarized in the sections below.

Case 1: Steady State Seepage Condition

This case represents the levee embankment under the design flood condition. The analysis assumes the duration of the design WSE is long enough to establish steady-state seepage conditions through the levee embankment. The phreatic surface and pore water pressures estimated within the embankment and levee foundation during steady-state seepage analyses (see *Section 5.3* above) were used in this stability evaluation.

Steady-state stability analyses were performed for 5 cross-section locations along Reaches 1 and 2A of Llagas Creek where levee embankments are present, and where the design water surface could be impounded against the levee embankment and potentially develop a steady state seepage condition. Analyses Sections 126+00 West, 134+00 East and West and 166+50 East and West were not modeled for steady state seepage because these sections are located in channelized sections of Reaches 2A and 2B of Llagas Creek where levee embankment protection for the design water surface is not necessary. As specified in EM 1110-2-1902, the required minimum factor of safety for the steady state seepage condition is 1.4 for the landside levee slope.

Case 2: Rapid Drawdown Condition

This case represents a three-stage rapid drawdown analysis approach (Duncan and Wright, 2005). The levee is assumed to have been saturated long enough under the design WSE (100-year, 24-hour storm) to develop steady state seepage conditions within the embankment, and the flood recedes too quickly for the embankment and foundation pore pressures to dissipate. The first phreatic surface in this case represents the design WSE. The second phreatic surface represents the post-drawdown water surface elevation, assumed to be the typical winter WSE within the channel, and an assumed ground water elevation in the vicinity of the levee prism based on observations during field explorations.

The rapid drawdown analyses were performed on the waterside slope of the levee. In the case of the Llagas Creek project, the creek is channelized at the north end of Reach 2A (Section 126+00 West) and throughout Reach 2B (Sections 134+00 and 166+50 east and west). For analysis sections at these locations, a rapid drawdown analysis was performed to check the stability of the channel slope on the waterside to see if there is potential for channel slumping under drawdown conditions that could impact the creek. As specified in EM 1110-2-1902, the required minimum factor of safety for the rapid drawdown condition is 1.1 for the waterside levee slope following a long duration flood stage, which is considered appropriate for this analysis.

5.4.2 *Strength Parameters Used for Analyses*

Material properties assigned to each identified soil layer within the stability models were selected using the results and data from the subsurface exploration program and laboratory testing, existing strength data from previous investigations in the Project vicinity, review of relevant literature and published ranges of values for different soil types, empirical correlations, and previous experience from similar evaluations. These properties included soil unit weight and strength values, for both effective (drained) and total (undrained) soil cohesion (c' and c) and internal friction angle (Φ' and Φ). Stability analyses material properties for each analysis cross-section are summarized in **Appendix F**.

5.4.3 *Levee Stability Evaluation and Results*

The results from stability analyses indicate that the estimated Factors of Safety are greater than the minimum allowable criteria of 1.4 for steady-state seepage stability and 1.1 for rapid drawdown stability, (i.e. acceptable), as prescribed in EM 1110-2-1902. Results of stability analyses are summarized in **Table 4**. A more comprehensive discussion of all Project stability analyses and results including approach, material properties, assumptions, and SLOPE/W output figures are presented in **Appendix F**.

5.5 Existing Conditions Seismic Analyses

Existing conditions seismic analyses were performed on selected cross-sections within the Lower Llagas Creek study area, including liquefaction and cyclic softening susceptibility and potential deformation of the levee resulting from an earthquake event with a 100-year return period.

As briefly discussed in *Section 3.6* and shown on **Figure 8**, the site is located within an area of moderate to high liquefaction susceptibility (Knudsen, et al., 2000). The terms liquefaction and cyclic softening have been used to describe the seismic behavior of saturated soils. These phenomena are generally characterized as loss of strength and stiffness during and following seismic shaking. Soils most susceptible to liquefaction are loose, clean, poorly graded, saturated sands while soils most susceptible to cyclic softening are clays and plastic silts. Liquefaction and cyclic softening can result in soil strength loss and deformations as observed in ground surface rupture, bearing failure, lateral spreading, and settlement at the ground surface.

A more detailed summary of the methodology used in seismic analyses is presented in detail in **Appendix G** and is briefly described below.

5.5.1 *Analyses Approach*

GEI evaluated the seismic stability of the existing Llagas Creek levees based on the estimated median water level in Llagas Creek combined with the 1% annual chance of earthquake exceedence (100-year return period), which is the criteria stipulated in USACE EC 1110-2-6067, USACE Process for the National Flood Insurance Program (NFIP) Levee System Evaluation. The seismic stability assessment of the levee was performed by GEI utilizing the following approach:

- The peak horizontal ground acceleration values (PGA's) for the various reaches at Llagas Creek were determined by GEI from the United States Geological Survey (USGS) 2008 Interactive Deaggregation Website.
- Based on these PGA values, the liquefaction and cyclic strength reduction susceptibility of the foundation soils was determined by the GEI for various analyses cross sections based on the estimated average winter groundwater elevations in the Llagas Creek channel.

The seismic analysis of the levee embankment followed the minimum required pseudo-static slope stability analysis per the USACE guidelines indicated in EC 1110-2-6067. Based on these guidelines, if the foundation materials are not susceptible to liquefaction or cyclic strength reduction under the 100-year earthquake return period, no further seismic analysis are necessary. For those cross-section locations where foundation strength loss is predicted under seismic loading conditions, the following additional analyses were performed by GEI.

- Post liquefaction reconsolidation settlements were estimated using a procedure by Idriss and Boulanger, 2008.
- Post Seismic soil strengths (i.e liquefied strengths for sands and residual strengths for fine grained soils) were used as input parameters in the SLOPE/W analyses for the analyzed sections.
- Based on guidance from USACE Engineering Circular EC-1110-2-6067 (USACE EC Guidelines), the post-earthquake slope stability factor of safety was determined using post seismic shear strengths.
- Based on USACE EC Guidelines, if the post-earthquake factor of safety was greater than 1.2, slope deformations were considered negligible (i.e. less than 1 inch) and no further evaluations were performed.
- If the post-earthquake factor of safety was less than 1.2, a modified Newmark approach by Makdisi and Seed was performed to determine the potential magnitude of post-seismic deformations of the levee structure. The Makdisi and Seed procedure is described in **Appendix G.**

For a given cross section, the factor of safety against liquefaction was determined by dividing Cyclic Resistance Ratio (CRR) values from clean sand blow count data $(N_1)_{60\ cs}$ and normalized corrected CPT tip resistance values by Cyclic Stress Ratio values (CSR's) generated by earthquake loading. If the computed factor of safety was less than 1.0, a granular layer was considered to be liquefiable. Once a soil layer was determined to be liquefiable, approximate undrained residual shear strength was determined based on empirical relationships by Seed and Harder (1990).

The undrained strength parameters for the fine grained materials were determined from empirical correlations, vane shear test data on foundation soils performed previously by the USDA in 1973, and undrained strength tests of on-site soils samples from the recent subsurface exploration program. The recent undrained strength testing includes Triaxial CU tests, Unconsolidated Undrained (UU) Triaxial tests, and Unconfined Compression tests). The undrained strength values for seismic stability are expressed in terms of total stresses (i.e. S_u strengths with $\phi = 0$ degrees). GEI made the assumption that fine grained alluvial materials and peats would be susceptible to strength reduction due to cyclic loading, so reduced undrained shear strength parameters were assigned to these materials.

The residual undrained shear strengths of the liquefiable granular soil layers and reduced undrained shear strength values of fine grained soils were used as input parameters for the pseudo-static slope stability and deformation analysis. Drained strengths were assigned for granular soils not expected to liquefy.

Liquefaction, cyclic softening, and post-seismic stability and deformation analyses were performed using the estimated peak ground acceleration (PGA) and earthquake magnitude. For this project, the PGA was assessed at 0.45 g for an earthquake magnitude M 6.5 on the

Calaveras Fault. Design groundwater level for liquefaction analyses was based on observations recorded during the sub-surface exploration program. The typical winter WSE within the Llagas Creek channel and an assumed ground water elevation in the vicinity of the levee prism were assumed for seismic stability analyses.

5.5.2 *Liquefaction and Post-Seismic Stability Evaluation and Results*

Results of the existing conditions seismic analyses are summarized below:

- The peak ground acceleration for the 1-in-100 return period for this site is estimated to be 0.45 g.
- Layers were identified within the foundation soils that are susceptible to liquefaction and cyclic strength reduction. The estimated post-seismic shear strengths for analysis are summarized in **Appendix G**.
- The post-seismic stability analyses resulted in an estimated factor of safety greater than 1.2 for both landside and waterside slopes of the analysis cross-sections developed at 50+00, 78+00, 92+50, and 106+50.
- Using Idriss and Boulanger (2008), we estimate post-liquefaction reconsolidation settlements of up to 4 inches along the levee alignments.

Based on these results, it appears that the levee embankments along the Lower Llagas Creek evaluation reach will be stable following an earthquake event with a 100-year return period. Vertical seismic deformations (vertical displacement plus post-liquefaction reconsolidation settlement) of the existing levee of up to 6 inches are estimated. Post-seismic stability analyses results are presented in **Table 4** and **Appendix G.**

5.6 Capacity Restoration Alternatives

As discussed in *Section 2.1*, the District is evaluating the existing channel in regard to providing 100, 50, 25, or 10-year flood protection, and has developed a design water surface for use in Project analyses. As reported by the District, problems related to hydraulic deficiencies of the Lower Llagas Creek channel include channel overtopping and inadequate freeboard in several areas within the project extents.

In order to restore adequate flow capacity and provide the desired level of flood protection along Lower Llagas Creek, the District has asked GEI to evaluate the feasibility of raising the height of the existing levees by constructing flood walls, adding compacted fill, or construction of an earth retention system on top of the existing levees. For this evaluation, GEI performed analyses for the end-of-construction slope stability case.

5.6.1 *End-of Construction Stability Analyses Approach*

End-of-Construction stability analyses were performed at the analyses cross-section location located at Station 50+00. This cross-section is considered to represent critical conditions in terms of additional loading resulting from construction required to raise the height of the existing levees as well as worst-case conditions for compressible foundations material (softer clays and peat layers) within the Lower Llagas Creek study area.

Analyses were conducted in general accordance with USACE Engineer Manual EM 1110-2-1913 and USACE Engineer Manual EM 1110-2-1902. Slope stability was analyzed for the end-of-construction design case. The end-of-construction stability evaluations were performed similar to the existing conditions stability evaluations discussed in *Section 5.4*. The approach for the end-of-construction case is summarized below.

Case 3: End-of-Construction Condition

This case represents slope stability following levee reconstruction. Undrained strengths are assumed for impervious levee embankments and foundation soils as these low permeability soils do not have sufficient time to drain once the load is placed. This loading condition assumes the construction will be completed in one phase. A conservative fill height of 3.8 feet was used in analyses. The typical winter WSE within the channel and an assumed ground water elevation in the vicinity of the levee prism were assumed for analyses. Strength parameters selected in end-of construction stability are summarized in **Appendix F**. As specified in EM 1110-2-1902, the required minimum factor of safety for the end-of-construction condition is 1.3 for both the landside and waterside levee slopes.

5.6.2 *End-of-Construction Levee Stability Evaluation and Results*

The results from stability analyses indicate that the estimated Factors of Safety are greater than the minimum allowable criteria of 1.3 for end-of-construction stability, (i.e. acceptable), as prescribed in EM 1110-2-1902. Results of end-of-construction stability analyses are summarized in **Table 4**. A more comprehensive discussion of all Project stability analyses and results including approach, material properties, assumptions, and SLOPE/W output figures are presented in **Appendix F**.

5.6.3 *Settlement Evaluation*

Mitigation of flood overtopping and freeboard deficiencies will be required along the Lower Llagas Creek alignment, as summarized in **Table 2**. Given the proposed levee raise or construction of floodwalls or earth retention system, the associated loads will increase the stress on the underlying soils, causing settlement. Consolidation settlement typically applies to cohesive soils (silts and clays) that compress in response to the dissipation of pore pressures over a relatively long period of time.

An evaluation of consolidation settlement at the feasibility design level was performed at cross-sections located at Station 50+00, Station 92+50, and Station 106+50, using results and laboratory data from the subsurface exploration program. The evaluation assumes the placement of additional fill over the existing levee prism and foundation soils, as this represents the estimated maximum fill section for mitigation of levee freeboard assuming the selection of the earthfill raise option (critical case loading condition) for the final design. The generalized stratigraphy modeled at Station 50+00 was determined to be the critical section stratigraphy for the Llagas Creek alignment, due to the presence of thin peat layers and thicker softer grained alluvium materials encountered in the levee foundation. These materials will compress when new loads, in addition to the stress that the soil is currently subjected, are placed on the soil from construction of freeboard mitigation features. The sections modeled at Station 92+50 and Station 106+50 represent typical estimated fill sections and levee stratigraphy north of approximately Station 90+00, where peat materials were not encountered in the levee foundation. The additional fill imparts an additional load on the existing levee and foundation soils and was modeled conservatively as an areal-type loading condition with no dissipation of load influence on the foundation soils with depth.

As shown in the table below, we estimate a primary consolidation settlement between approximately 2 to 9 inches beneath the center of the existing levee, based on a new load equivalent to height of new fill required to meet the minimum freeboard criteria. We judge that settlements throughout the project area are reflected by this range of estimated settlement based on the areal loading assumptions described above. This assumption should be refined when a preferred alternative is selected and the loading conditions associated with this alternative are better defined. Construction of flood walls or constrained fills only on the levee crest will result in less estimated settlement. Details of the settlement evaluation, including settlement and consolidation parameters, calculations, and the generalized stratigraphy modeled are included in **Appendix H**.

Settlement Evaluation Summary Table

Section	Estimated Fill Thickness (feet)	Primary Consolidation Settlement (inches)
Station 50+00, Typical Levee	3.8	9.3
Station 92+50, West Levee	2.0	2.8
Station 92+50, East Levee	2.0	3.0
Station 106+50, Typical Levee	2.3	2.5

6. Conclusions and Recommendations

GEI performed a geotechnical evaluation of the levees along Lower Llagas Creek following USACE guidelines, by performing field explorations, laboratory testing, site characterization, assessment of engineering properties, development of geometric and stratigraphic cross-sections and engineering analyses. *Section 6* presents conclusions of the geotechnical engineering study, including steady state seepage, stability and seismic performance of the levees under design water surface flood levels. A discussion of mitigation alternatives are also presented where deficiencies are identified.

6.1 Underseepage

Based on the limited crest exploration data, analyses indicate that some portions of the levees either do not meet USACE criterion for steady state seepage (Station 106+50, west and east levees) or are considered marginal (Station 126+00 east levee). USACE guidelines indicate maximum gradients of 0.5 which provides a factor of safety of about 1.6 for uplift of the landside blanket. Remediation of the underseepage deficiency is necessary to meet USACE and FEMA certification guidelines.

For conceptual level planning and costing purposes, the area (levee extent) where underseepage mitigation measures should be considered extends from approximately Station 100+00 to Station 130+00. This identified levee segment is based on our review of the subsurface profiles on **Figures 12 through 14**, where permeable sand layers appear to be closer to the channel invert and surrounding ground surface, and the blanket appears to be thinner than other levee segments.

The exploration program completed for this study included only widely spaced CPTs and borings and we recommend additional explorations to better estimate the stratigraphy and limits of the underseepage deficiency. Additional seepage analyses should be performed as discussed in *Section 6.3* below. Further explorations will also be required to prepare design level evaluations of mitigations.

Alternatives to mitigate seepage include cutoff walls, extending through the levee and fully penetrating the underlying permeable material (sand) or seepage berms extending landside of the levee toe. However, at this time insufficient data exist to assess remedial measures and further study of the levees. Aadditional explorations and testing is warranted. Additional explorations along the levee crest, at the landside and waterside levee toe, and landside of the toe are needed to further define the area of concern, the stratigraphy and the engineering properties of the soils.

We recommend considered the following alternatives for underseepage mitigation:

- Soil-cement bentonite cut-off wall through the levee embankment and foundation
- Sheet piling through the waterside levee crest
- Landside Seepage Berm

These alternatives are described in more detail below:

6.2.1 *Soil-Cement-Bentonite Cut-off Wall*

The soil-cement-bentonite cutoff wall (SCB Wall) would consist of a trench excavated through the levee embankment and underlying foundation and backfilled with a soil-cement-bentonite mixture to create a low permeability cutoff to underseepage. Based on the stratigraphy estimated at Sections 106+50 and 126+00, the SCB wall would need to extend to a depth of approximately 30 to 40 feet below the levee crest in order to tie at least 3 feet into a low permeability soil layer in the levee foundation. SCB walls are typically 2 to 3 feet thick and excavated to depth with hydraulic excavators. During excavation and prior to backfilling with the SCB mixture, the trench is filled with bentonite slurry to keep the trench walls from caving during excavation. Some of the issues to consider for this alternative that may impact feasibility, cost and constructability are as follows:

- The levee will need to be degraded in order to construct a construction work pad for the SCB wall installation. A typical work pad width for the SCB wall is on the order of 40 feet. The levees at Llagas Creek may need to be degraded approximately up to approximately 1/3 of the levee height to achieve this pad width. Levee degradation would likely result in removal of vegetation and the environmental ramifications must be assessed.
- The levee will need to be reconstructed and regarded after installation of the wall using materials that meet USACE and District specification for levee fill. A cutoff wall permanent cap will also need to be constructed prior to levee reconstruction.
- Construction of the SCB wall will have potentially significant environmental consequences associated with disturbance of the levee footprint during construction and handling and disposal of excess SCB materials.
- There are safety considerations during construction associated with an open slurry trench, which could be 100 to 200 feet in length prior to backfilling with the SCB.

6.2.2 *Sheet Piling Through Levee Crest*

A sheetpile cutoff wall would consist of interlocking impermeable sheetpiles driven through the levee crest and into underlying foundation soils to develop a cutoff to under seepage. Typically steel materials are used for sheetpiles, but there are alternatives such as vinyl sheetpiles that will not corrode, and are a sustainable construction material. Sheetpiles can be driven using several methods including impact and vibratory hammers. For underseepage mitigation in Reach 2A of Llagas Creek, the sheetpile cutoff wall depth would be similar to the SCB wall (approximately 30 to 40 feet below the crest). Some of the issues to consider for this alternative that may impact feasibility, cost and constructability are as follows:

- The sheetpile alignment could be installed on the waterside of the crest and sheetpile elements could extend above the final levee grade to develop an I-wall for use in areas that require freeboard mitigation.
- Individual sheetpiles must remain connected once installed to provide a positive cutoff to underseepage. Therefore, stringent QA controls are necessary during installation.
- The levee may need be degraded to develop a work pad for sheetpile installation, although the vertical extents of the degrade are expected to be less than for an SCB wall (minimum 20 foot width depending on type of sheetpile driving equipment used).
- The levee will need to be reconstructed and regraded after installation of the wall using materials that meet USACE and District specification for levee fill.
- Sheetpiles are often a preferred seepage mitigation technique in areas where environmental and access restrictions preclude the use of an SCB wall.

6.2.3 *Landside Seepage Berm*

The landside seepage berm would typically consist of a 3 to 5 foot thick layer of fill material extending a minimum of 4 times the levee height outward from the landside toe of the levee. Assuming an average levee height of 10 feet in the mitigation area, the minimum width of seepage berms at Llagas Creek would be 40 feet.

Seepage berms are used to lengthen the seepage path at the landside of the levee, lowering the exit gradient through the surface blanket and the potential for boils to occur. The bottom layer of the seepage berm could also include a gravel blanket drain to intercept seepage and provide ballast to resist boil development. Some of the issues to consider for this alternative that may impact feasibility, cost and constructability are as follows:

- Land acquisition may be necessary landside of the levees in order to accommodate the required seepage berm footprint.

- The seepage berm does not allow for a positive cutoff to seepage like a cutoff wall. Drainage conveyance systems such as ditches or conveyance pipes may be required at the toe of the seepage berms, particularly if a gravel blanket drain is installed at the bottom of the berm. If a gravel blanket drain is not installed, there is the potential that surface boils may occur at other locations adjacent to the toe of the berm.

6.2.4 *Evaluation of Mitigation Alternative Relative Cost*

All the mitigation measures presented in Sections 6.1 will be effective to reduce underseepage gradients to within the USACE criteria (i.e. a maximum gradient of 0.5). The SCB and steel sheet piles will provide a positive cutoff to seepage, where the landside seepage berm will provide a ballast against underseepage at the levee toe, but will not cutoff seepage flows from waterside to landside. We estimate that the landside seepage berm option would likely be the most cost effective mitigation measure based on overall construction costs per lineal feet of levee mitigated. We estimate that construction costs of a SCB wall will be approximately twice the costs of a landside seepage berm and the construction costs of a steel sheetpile wall will be approximately 3.5 times the cost of a landside seepage berm. However, the landside seepage berm will require the acquisition of property adjacent to the levee which may have add additional cost and environmental challenges.

6.3 Additional Subsurface Exploration and Seepage Analyses

As mentioned in *Section 5.3*, the average vertical exit gradient at the landside levee toe exceeded the USACE maximum criterion (i = 0.5) at Section 106+50 (east and west levee), due to the thin low permeability blanket materials and more elevated coarse grained alluvial layers beneath the levee prism and levee toe at this Section. In addition, the average vertical exit gradient estimated at Section 126+00 (east levee only) is considered marginal (0.48). In order to more accurately delineate the lateral extents, thickness, and permeability characteristics of these elevated coarse grained materials, we recommend performing additional subsurface explorations to support further underseepage analyses and evaluation and design of mitigation alternatives.

Based on the subsurface information collected during the exploration program, we anticipate additional explorations to be performed between approximate Station 100+00 and 130+00, primarily at locations landside of the existing levee prism (both east and west levees, where present). These exploration locations would require access permission from the respective landowner representatives, as these locations are outside of District property. Where possible, waterside explorations should also be performed.

We estimate approximately 2-3 days of CPT exploration (8-12 locations) and 2-3 days of hollow-stem or rotary wash drilling (4-6 locations), with explorations extending through the coarse grained alluvial layers and into relatively impermeable materials below. If waterside exploration is not possible using conventional methods because of environmental restrictions, hand portable methods could be employed to minimize disturbance within the creek. Soil samples would be recovered for laboratory testing of hydraulic conductivity characteristics. Data and information obtained from any additional subsurface exploration and laboratory testing would be used in refining existing seepage models developed at current analysis cross-sections and in developing additional analysis cross sections within this reach.

6.4 Existing Conditions Steady-State Seepage Stability and Rapid Draw Down Stability Analyses

Seven representative cross-sections were evaluated for stability under steady-state seepage and rapid draw down conditions for the Design Water Surface flood level. The results from stability analyses indicate that the estimated Factors of Safety are greater than the minimum allowable criteria of 1.4 for steady-state seepage stability and 1.1 for rapid drawdown stability, (i.e. acceptable), as prescribed in EM 1110-2-1902.

6.5 Existing Conditions Seismic Analyses

Four representative cross-sections were evaluated for using estimated 1% annual chance of earthquake exceedence criteria (100-year return period) combined with the estimated median water level in Llagas Creek. Liquefaction, cyclic softening, and post-seismic stability and deformation analyses were performed using the estimated peak ground acceleration (PGA) and earthquake magnitude. For this project, the PGA was assessed at 0.45 g for an earthquake magnitude M 6.5 on the Calaveras Fault. Based on these results, it appears that the levee embankments along the Lower Llagas Creek evaluation reach will be stable following an earthquake event with a 100-year return period. Vertical seismic deformations (vertical displacement plus post-liquefaction reconsolidation settlement) of the existing levee of up to 6 inches are estimated.

6.6 End-of Construction Stability Analyses and Settlement Evaluation

As mentioned in *Section 5.6*, an evaluation of consolidation settlement at the feasibility design level was performed at the critical analysis cross-section located at Station 50+00. The evaluation assumes the placement of an additional 3.8 feet of fill over the existing levee prism and foundation soils at the landside toe at Station 50+00, as this represents the estimated maximum fill section for mitigation of levee freeboard assuming the selection of the earthfill raise option (critical case loading condition) for the final design. The results from stability analyses for this loading condition indicate that the estimated Factors of Safety are greater than the minimum allowable criteria of 1.3 for end-of-construction stability, (i.e. acceptable), as prescribed in EM 1110-2-1902.

We estimate a primary consolidation settlement of up to 7 inches beneath the center of the existing levee, based on a new load equivalent to 3.8 feet of new fill. This assumption will be refined when a preferred alternative is selected and the loading conditions associated with this alternative are better defined.

6.7 Levee Raise for Freeboard

The February 2011 Conceptual Alternatives Evaluation report (February 2011 Report) presents options for freeboard mitigation in Reaches 1 and 2A, including:

- Levee raises with a conventional compacted earthfill raise on the landside of the levee
- Structural floodwalls on the waterside of the levee
- Mechanically stabilized earth with earthfilled baskets facing on both the landside and waterside levee crest hinges

These levee raise options are all feasible from a geotechnical standpoint as discussed in *Section 5.6*. Unit costs for freeboard mitigation alternatives are presented in the Conceptual Alternatives Report, Table C-1. The unit costs (and relative costs) reported are consistent with costs estimated for similar projects performed by GEI. We note that it may be possible to reduce the costs of the mechanically stabilized earth option by substituting the earthen or rock filled basket facing with a welded wire mesh. Further analyses and design will be needed to provide overall construction cost estimates for the Lower Llagas Creek Capacity Restoration Project.

As Discussed with the District during a Project meeting (May 20, 2012), specific recommendations and geotechnical design criteria for levee raise alternative(s) including excavation and site work, sub-grade preparation, proper placement of fill and backfill, lateral earth pressures, and applicable erosion control measures (Contract Scope of Services; Task 5, Items 3; i through l) will be developed once the District has selected a preferred levee raise alternative.

6.8 General Comments and Recommendations

6.8.1 *Failure Geometry*

During stability analyses, failure geometry was assumed to be greater than 5-feet in thickness, as this was taken as the minimum thickness of a failure mass that would represent a significant slope failure that could compromise overall levee performance and require immediate repair. Shallow or surficial slope failures were not evaluated and are considered to be levee maintenance issues. Levees should be inspected following significant flood flows or earthquakes to assess the extent of shallow or surficial slope failures and an assessment made as to the effect of these failures, if any, on the overall performance of the levees.

6.8.2 *Future Changes or Observations*

Any future changes in the configuration of the existing levees and surrounding areas or any observations that might suggest a change in performance conditions should be evaluated by the District to ensure that the required levels of flood control are maintained within the identified evaluation reaches of the Llagas Creek Levees.

7. Limitations

The assessments and recommendations contained in this report are based on the limited subsurface geotechnical data obtained from the subsurface explorations conducted for this study and topographic data provided by the District for project use. These explorations indicate subsurface conditions only at specific locations and times, and only to the depths penetrated. Variations may exist and conditions not observed or described in this report could be encountered. Our assessments, conclusions, and recommendations are based on our analysis of the observed conditions and our understanding of the project as expressed verbally and in writing by the Santa Clara Valley Water District. If conditions other than those described in this report are encountered, we should be notified in order to provide additional recommendations, if warranted.

This report has been prepared for the exclusive use of the District for specific application to the geotechnical evaluation of the existing Lower Llagas Creek levees and channel, within the designated evaluation reach, as described herein. In the event that there are any changes in the ownership, nature, design, or location of the proposed project, or if any future additions are planned, the conclusions and recommendations contained in this report should not be considered valid unless 1) the project changes are reviewed by GEI Consultants Inc., and 2) conclusions and recommendations presented in this report are modified or verified in writing. Reliance on this report by others must be at their risk unless we are consulted on the use or limitations. We cannot be responsible for the impacts of any changes in geotechnical standards, practices, or regulations subsequent to performance of services without our further consultation. We can neither assure the accuracy of the information supplied by others, nor accept consequences for use by others of segregated portions of this report.

Our services consist of professional opinions, conclusions, and recommendations that are made in accordance with generally accepted geotechnical engineering principles and practices. This warranty is in lieu of all other warranties, either express or implied.

8. References

Aydin, A.J., Johnson, A.M., and Fleming, A.M., 1992, Right-lateral-reverse surface rupture along the San Andreas and Sargent faults associated with the Octoer 17, 1989, Loma Prieta, California, earthquake: Geology, vol. 20, no. 12, p. 1063-1067.

Boulanger, R.W., and Idriss, I.M., 2004, Evaluating the Potential for Liquefaction or Cyclic Failure of Silts and Clays, Report No. UCD/CGM-04/01, University of California at Davis.

Bray, J.D. et al., 1988, Simplified Seismic Design Procedure for Geosynthetic Lined, Solid Waste Landfills, Geosynthetics International 1998, Vol. 5, Nos. 1 and 2.

California Department of Water Resources (DWR), 2010, Guidance Document for Geotechnical Analyses, Urban Levee Geotechnical Evaluations Program, Revision 8.0, (Prepared by URS).

California Department of Water Resources (DWR), 2008, Proposed Interim Levee Design Criteria for Urban and Urbanizing Area State-Federal Project Levees

California Dept. of Water Resources (DWR), 1981, Evaluation of ground water resources, South San Francisco Bay, Vol. IV, South Santa Clara County Area: DWR, Bulletin 118-1, dated May 1981.

Carrier, W. 2003. Goodbye, Hazen; Hello, Kozeny-Carman, *Journal of Geotechnical and Geoenvironmental Engineering*, Vol. 129, No. 11.

Dibblee, T.W., Jr., 2005a, Preliminary geologic map of the Gilroy quadrangle, Santa Clara County, California: Dibblee Foundation, Map DF-169.

Dibblee, T.W., Jr., 2005b, Preliminary geologic map of the Mt. Madonna quadrangle, Santa Clara County, California: Dibblee Foundation, Map DF-168.

Dibblee, T.W., Jr., 2005c, Preliminary geologic map of the Chittenden quadrangle, Santa Clara County, California: Dibblee Foundation, Map DF-228.

Dibblee, T.W., Jr., 2005d, Preliminary geologic map of the San Felipe quadrangle, Santa Clara County, California: Dibblee Foundation, Map DF-229.

Duncan, J.M. and Wright, S.G., 2005, Soil Strength and Slope Stability, John Wiley & Sons, Inc., New Jersey.

FEMA, 1999, National Flood Insurance Program (NFIP), Federal Emergency Management Agency, Title 44 Code of Federal Regulations Section 65.10 (b) Part (4): Mapping of Areas protected by Levee Systems.

Geo-Slope International, Ltd. 2007. Seepage Modeling with SEEP/W 2007. 2nd Edition.

Geo-Slope International, Ltd. 2007. Stability Modeling with SLOPE/W 2007. 2nd Edition.

Graymer, R.W., 1997, Geology of the southernmost part of Santa Clara County, California: a digital database: US Geological Survey Open-File Report 97-710.

Grossinger, R.M., E.E. Beller, M.N. Salomon, A.A. Whipple, R.A. Askvold, C.J. Striplen, E. Brewster, and R.A. Leidy, 2008, South Santa Clara Valley Historical Ecology Study, including Soap Lake, the Upper Pajaro River, and Llagas, Uvas-Carnadero, and Pacheco Creeks, San Francisco Estuary Institute, Oakland, California.

Hart, E.W. and Bryant, W.A., interim rev. 2007, Fault-rupture hazard zones in California; Alquist-Priolo Special Studies Zones Act of 1972 with index to special studies zones maps: California Div. of Mines and Geology, Special Pub. 42.

Helley, E.J., and Brabb, E.E., 1971, Geologic map of late Cenozoic deposits, Santa Clara County, California: US Geological Survey Miscellaneous Field Studies Map MF-335.

Hoose, S.N., 1986, Was There a Great Pleistocene Lake San Benito?: M.S. Thesis, San Jose State University, 174 p.

Idriss, I.M., and Boulanger, R.W., 2008, Soil Liquefaction During Earthquakes", Earthquake Engineering Institute, MNO-12.

Jenkins, O.P., 1973, Pleistocene Lake San Benito: California Geology, July 1973, Vol. 26, No. 7.

Jennings, C.W., and Bryant, W.A., 2010, 2010 fault activity map of California: California Geological Survey, Geologic Data Map No. 6.

Karavanjian, E. Jr., Matasovic, N., Hadj-Hamou, T., Sabatini, P.J., 1997, Design Guidance: Geotechnical Earthquake Engineering for Highways, Vol. 1: Design Principals, Geotechnical Engineering Circular 3, FHWA-SA-97-076, Federal Highways Administration, U.S. Department of Transportation, Washington, D.C.

Knudsen, K.L. et al., 2000, Preliminary maps of Quaternary deposits and liquefaction susceptibility, nine-county San Francisco Bay region, California: a digital database: US Geological Survey Oopen-File Report 00-444, ver 1.0.

Mactec (Mactec Engineering and Consulting, Inc.,) 2006, Llagas Subbasin characterization, Santa Clara County, Olin/Standard Fusee, Morgan Hill, California: consultant's report for Olin, and Santa Clara Valley Water District, Project No. 6300060006 04, dated March 29, 2006.

Mactec, 2007, Llagas Subbasin characterization – 2006 – Santa Clara County, Olin/Standard Fusee, Morgan Hill, California: consultant's report for Olin, and Santa Clara Valley Water District, Project No. 6300060006 04, dated January 31, 2007.

McLaughlin, R.J. and 8 others, 2000, Neogene contraction between the San Andreas fault and the Santa Clara Valley, San Francisco Bay region, California; in: Ernst, W. G. and Coleman, R.G., eds., Tectonic Studies of Asia and the Pacific Rim, a tribute to Benjamin M. Page, Internat'l Book Series, Vol. 3, p. 265-294.

Prescott, W.H., and Burford, R.O., 1976, Slip on the Sargent fault: Bull. Seismol. Soc. America, vol. 66, pp. 1013-1016.

RMC, 2005, Pajaro River Watershed Study, Phase 3 and 4a: unpublished consultant's report for the Pajaro River Watershed Flood Prevention Authority, dated February, 2005.

Rogers, T.H., and Williams, J.W., 1974, Potential seismic hazards in Santa Clara county: California Div. of Mines and Geology, SR 107.

Santa Clara Valley Water District, 2010, Problem Definition and Refined Objectives Report for the Lower Llagas Creek Capacity Restoration Project, prepared by the Capitol Program Services Division

Seed, R.B., et. Al., 2003, Recent Advances in Soil Liquefaction Engineering: A Unified and Consistent Framework, 26th Annual ASCE Los Angeles Technical Spring Seminar, Keynote Presentation, Long Beach, CA, pp. 1-71.

Seed, R.B., Harder, L.F.H., Jr., 1990, SPT-based Analysis of Cyclic Pore Pressure Generation and Undrained Residual Shear Strength, in Proceedings of "H.B. Seed Memorial Symposium, Vol. II, May, pp. 351-376.

Sharma, H.D. and Lewis, S.P., 1994, Waste Containment Systems, Waste Stabilization and Landfills Design and Evaluation.

Sowers, J.M. and Henkle, J.E., 2009, Creek and Watershed Map of Morgan Hill & Gilroy: Oakland Museum of California, Oakland, CA, 1:25,800 scale.

State of California Department of Conservation California Geological Survey (CGS), 2010, "Fault Activity Map of California."

State of California Department of Conservation California Geological Survey (CGS), 2006, "Seismic Hazard Zone Report for the Mountain View 7.5 Minute Quadrangle, Santa Clara, Alameda, and San Mateo counties, California."

Terzaghi, K. and Peck, R. 1967. Soil Mechanics in Engineering Practice, 2nd Ed. John Wiley and Sons.

United States Army Corps of Engineers, 2000, Engineer Manual EM 1110-2-1913, Design and Construction of Levees.

United States Army Corps of Engineers, 2003, Engineer Manual EM 1110-2-1902, Slope Stability.

United States Geological Survey, 2011, New Earth Explorer – Database for Aerial Photography and Surveys, http://edcsns17.cr.usgs.gov/NewEarthExplorer/.

United Stats Geological Survey, 2012, National Water Information System: Web Interface, Creek Flow Data for USGS 11153650 LLAGAS C NR GILROY, http://waterdata.usgs.gov/ca/nwis/uv/?site_no=11153650&PARAmeter_cd=00065,00060.

United States Geological Survey, 2008, Forecasting California's Earthquakes – What Can We Expect in the Next 30 years? Open File Report 2008-3027.

URS Corporation (2007), Guidance Document for Geotechnical Analyses, DWR Urban Levee Geotechnical Evaluations Program, Report to DWR, Division of Flood Management, dated July 2, 2007.

Wagner, D.L., and others, 2002, Geologic map of the Monterey 30' x 60' quadrangle and adjacent areas, California: California Geological Survey, Regional Geologic Map No. 1, 1:100,000.

Wentworth, C.M., Blake, M.C., McLaughlin, R.J., and Graymer, R.W., 1998, Preliminary geologic map of the San Jose 30 x 60 minute quadrangle, California: a digital database: US Geological Survey Open-File Report 98-795, scale 1:100,000.

Working Group on California Earthquake Probabilities (WGCEP), 2003, Earthquake probabilities in the San Francisco Bay region 2002-2031: US Geological Survey Open-File Report 03-214.

WGCEP, 2008, The uniform California earthquake rupture forecast, version 2 (UCERF 2): US Geological Survey Open-File Report 2007-1437.

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Figure 9 – Site and Field Exploration Plan (9a-9e; Sheets 1 through 5)

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Figure 11 – Sub-Surface Profile; Cover Sheet

Figure 12 – Sub-Surface Profile; Station 48+00 to 90+00

Figure 13 – Sub-Surface Profile; Station 90+00 to 135+00

Figure 14 – Sub-Surface Profile; Station 135+00 to 180+00

Figure 15 – Channel Cross-Section; Station 50+00

Figure 16 – Channel Cross-Section; Station 78+00

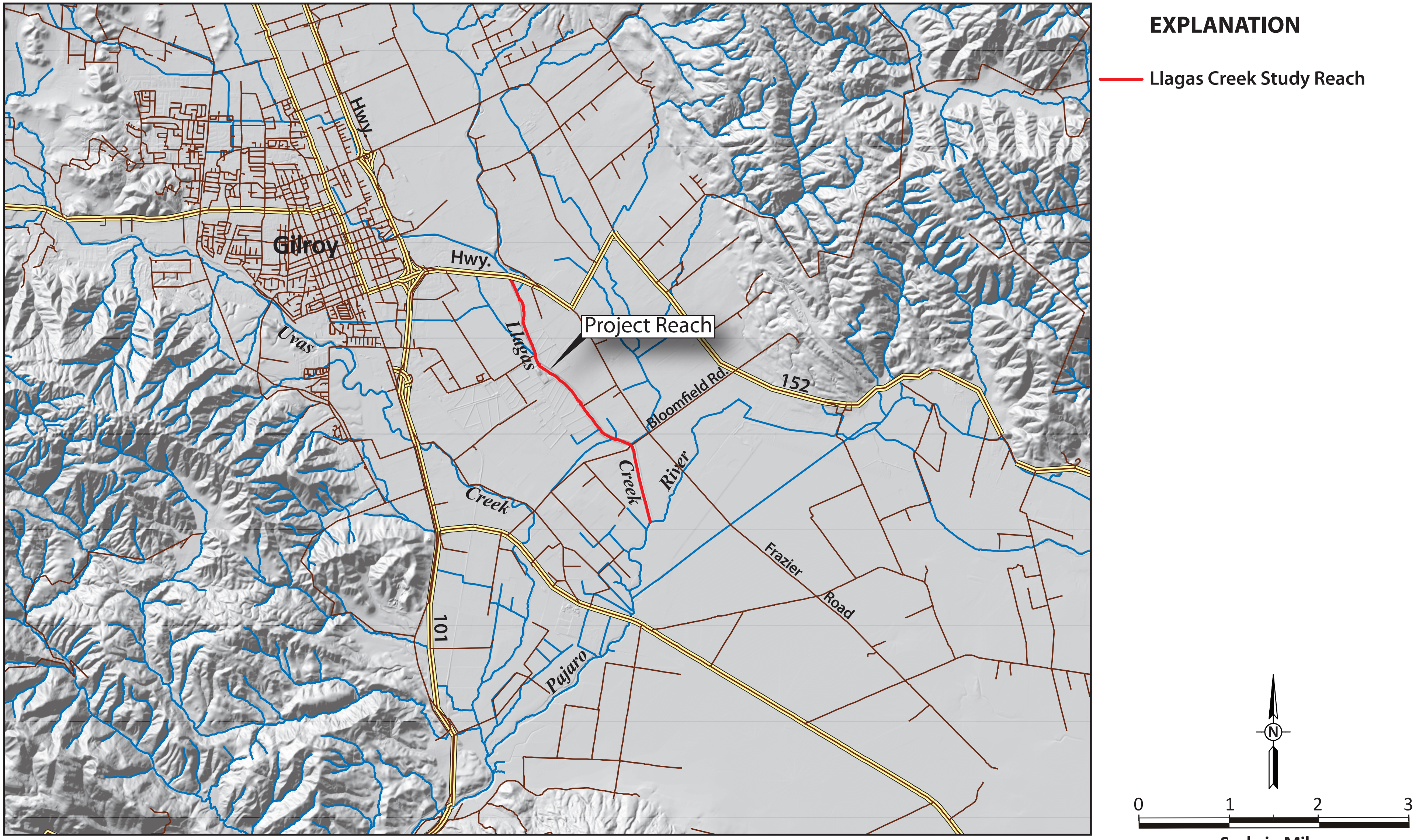
Figure 17 – Channel Cross-Section; Station 92+50

Figure 18 – Channel Cross-Section; Station 106+50

Figure 19 – Channel Cross-Section; Station 126+00

Figure 20 – Channel Cross-Section; Station 134+00

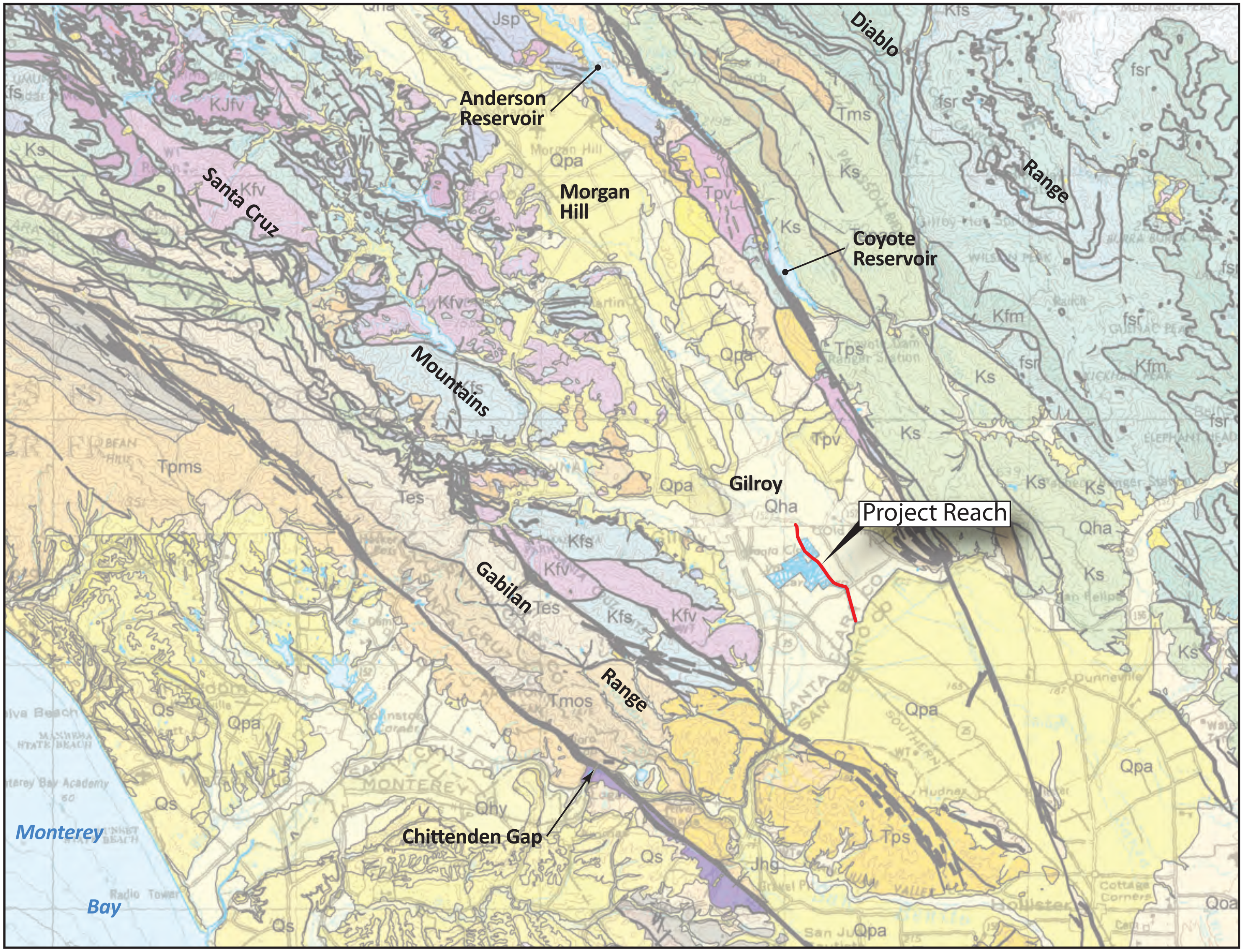
Figure 21 – Channel Cross-Section; Station 166+50



Base Map: National Elevation Dataset, 1/3 Arc Second

PACIFIC
GEOTECHNICAL
ENGINEERING

DATE	SITE VICINITY AND PROJECT LOCATION MAP	FIGURE
May 2012		1
SCALE	Lower Llagas Flood Control Project Santa Clara County, California	PROJECT
As Shown		2011.0191 Phase 100



Base Map: Modified from Graymer, et.al., 2006

EXPLANATION

EARTH MATERIALS

▢	Qha	Alluvium (Holocene)
▢	Qpa	Alluvium (Pleistocene)
▢	QTs	Sediments (early Pleistocene and (or) Pliocene)
▢	Tps	Sedimentary rocks (Pliocene)
▢	Ks	Great Valley Complex sedimentary rocks (Cretaceous)
▢	Kfs	Franciscan Complex sedimentary rocks (Cretaceous)
🟥		Llagas Creek Study Reach

N

0 10 20

Scale in Miles

PACIFIC
GEOTECHNICAL
ENGINEERING

DATE
May 2012

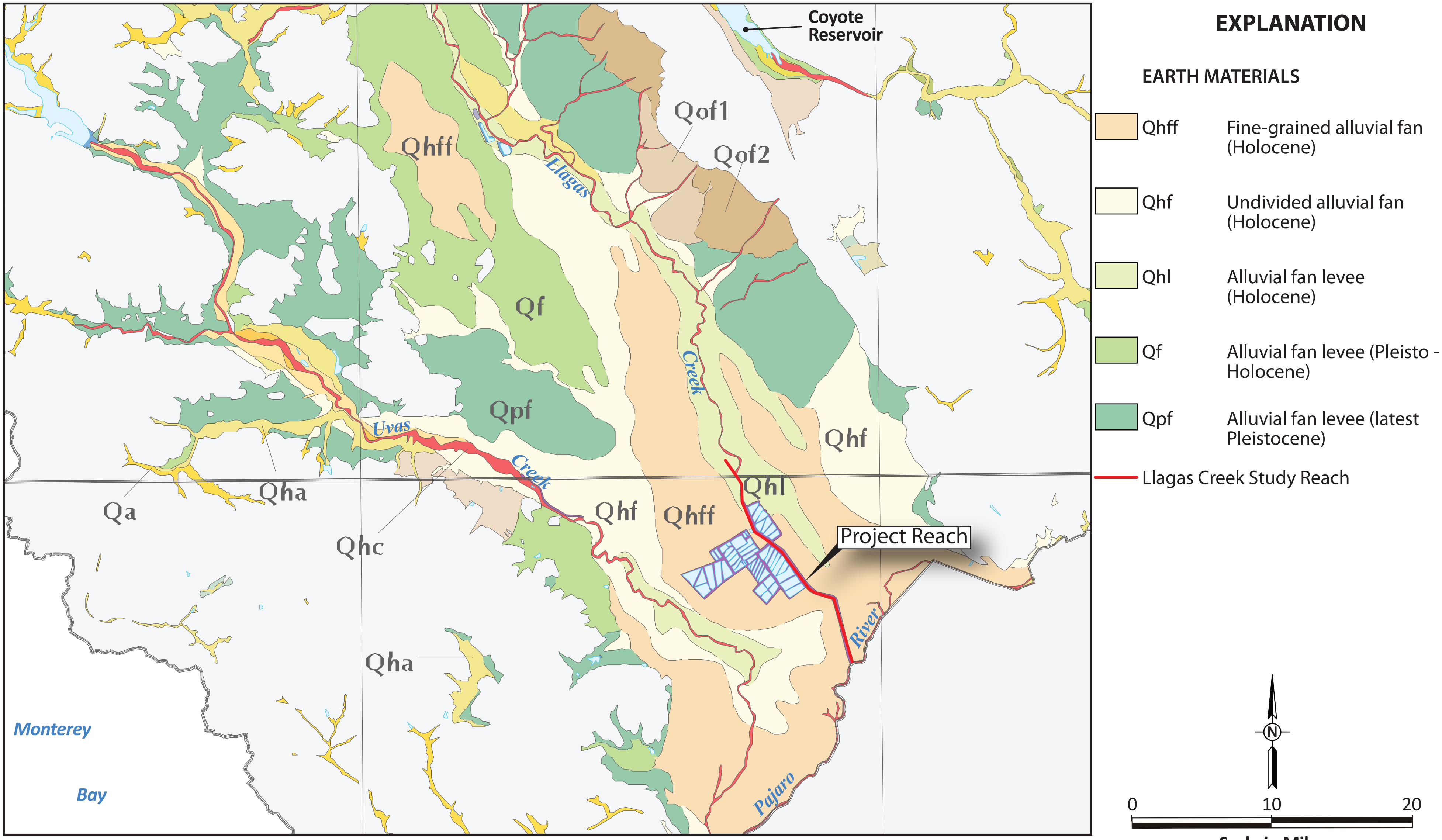
SCALE
As Shown

REGIONAL GEOLOGIC INDEX MAP

Lower Llagas Flood Control Project
Santa Clara County, California

FIGURE
2

PROJECT
2011.0191
Phase 100



EXPLANATION

EARTH MATERIALS

Qhff	Fine-grained alluvial fan (Holocene)
Qhf	Undivided alluvial fan (Holocene)
Qhl	Alluvial fan levee (Holocene)
Qf	Alluvial fan levee (Pleisto - Holocene)
Qpf	Alluvial fan levee (latest Pleistocene)

— Llagas Creek Study Reach

Base Map: Modified from Knudsen, et.al., 2000

PACIFIC
GEOTECHNICAL
ENGINEERING

DATE
May 2012

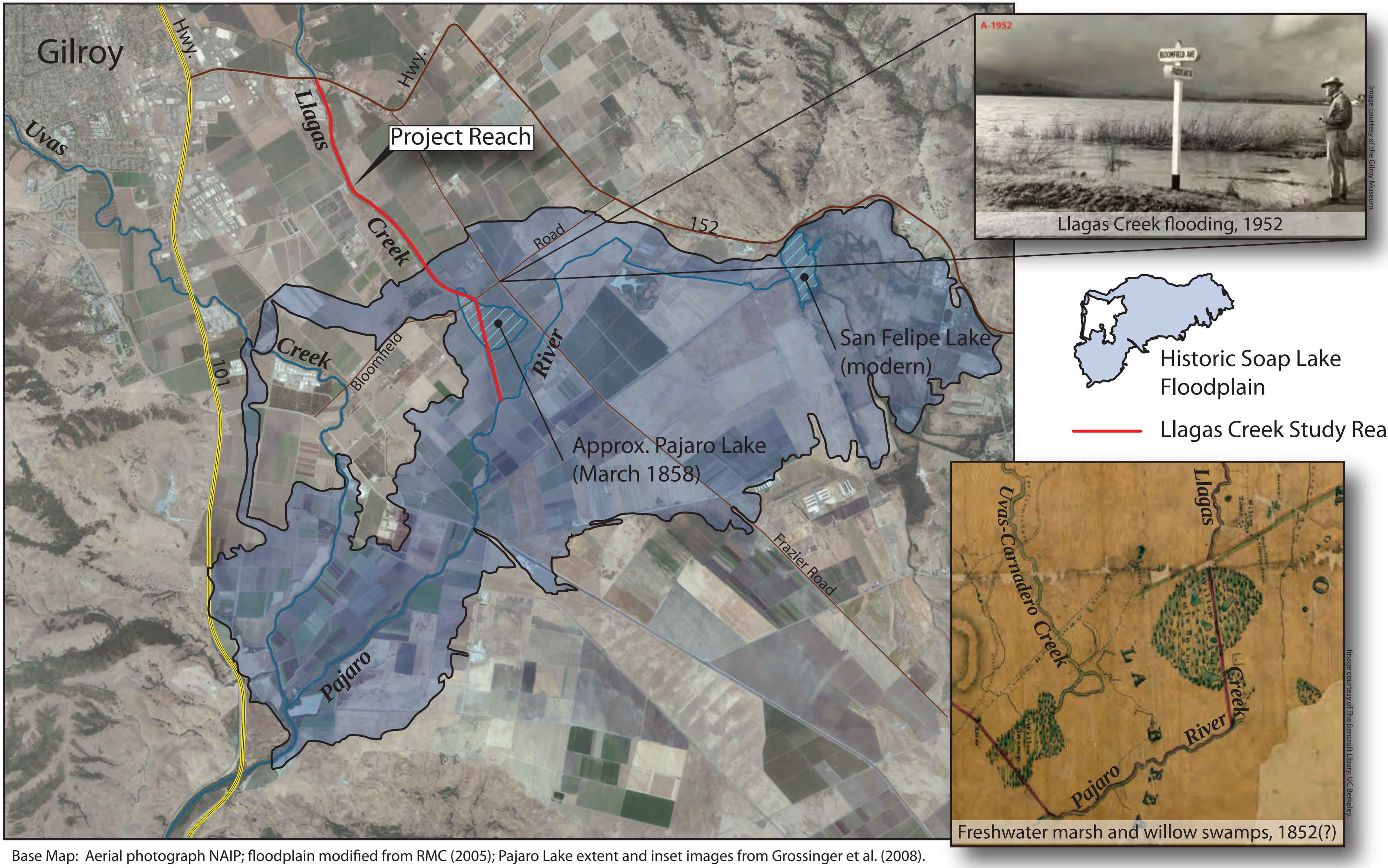
SCALE
As Shown

REGIONAL QUATERNARY DEPOSITS MAP

Lower Llagas Flood Control Project
Santa Clara County, California

FIGURE
3

PROJECT
2011.0191
Phase 100



Llagas Creek flooding, 1952

Freshwater marsh and willow swamps, 1852(?)

Base Map: Aerial photograph NAIP; floodplain modified from RMC (2005); Pajaro Lake extent and inset images from Grossinger et al. (2008).

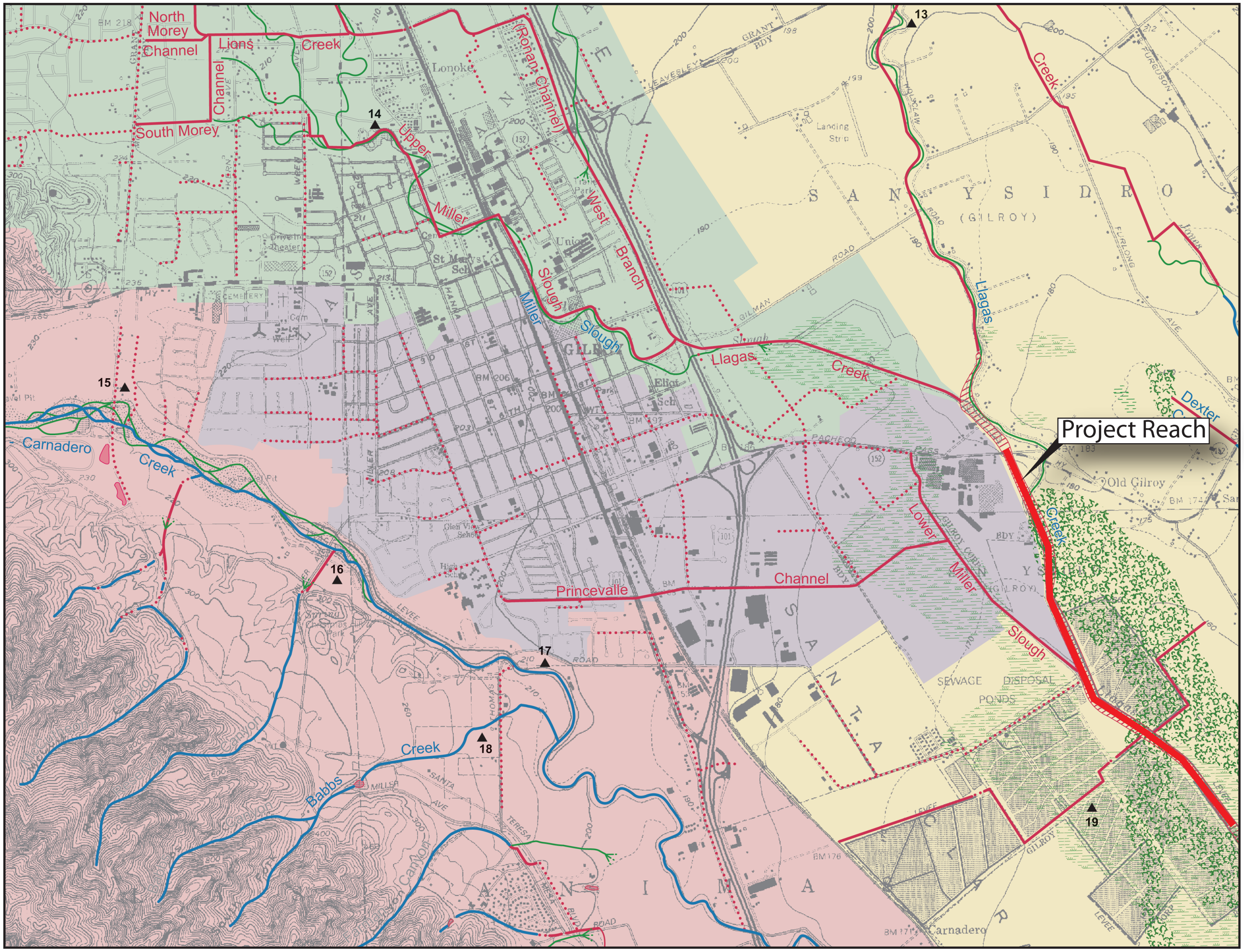
N

0 1 2

Scale in Miles

PACIFIC GEOTECHNICAL ENGINEERING

DATE	HISTORIC SOAP LAKE FLOODPLAIN	FIGURE
May 2012		**4**
SCALE	Lower Llagas Flood Control Project Santa Clara County, California	PROJECT
As Shown		**2011.0191** **Phase 100**



Base Map: Modified from Sowers and Henkle, 2009

EXPLANATION

- 〰 Creeks, watershed area ≥ 0.2 km^2
- ⋯ Underground culverts and storm drains ≥ 24" diameter
- ― Engineered channels
- ▨ Engineered channel ≥ 200 ft. wide
- 🟨🟩🟪🟥 Present watersheds, drains to creeks

Historical Features 1800-1900

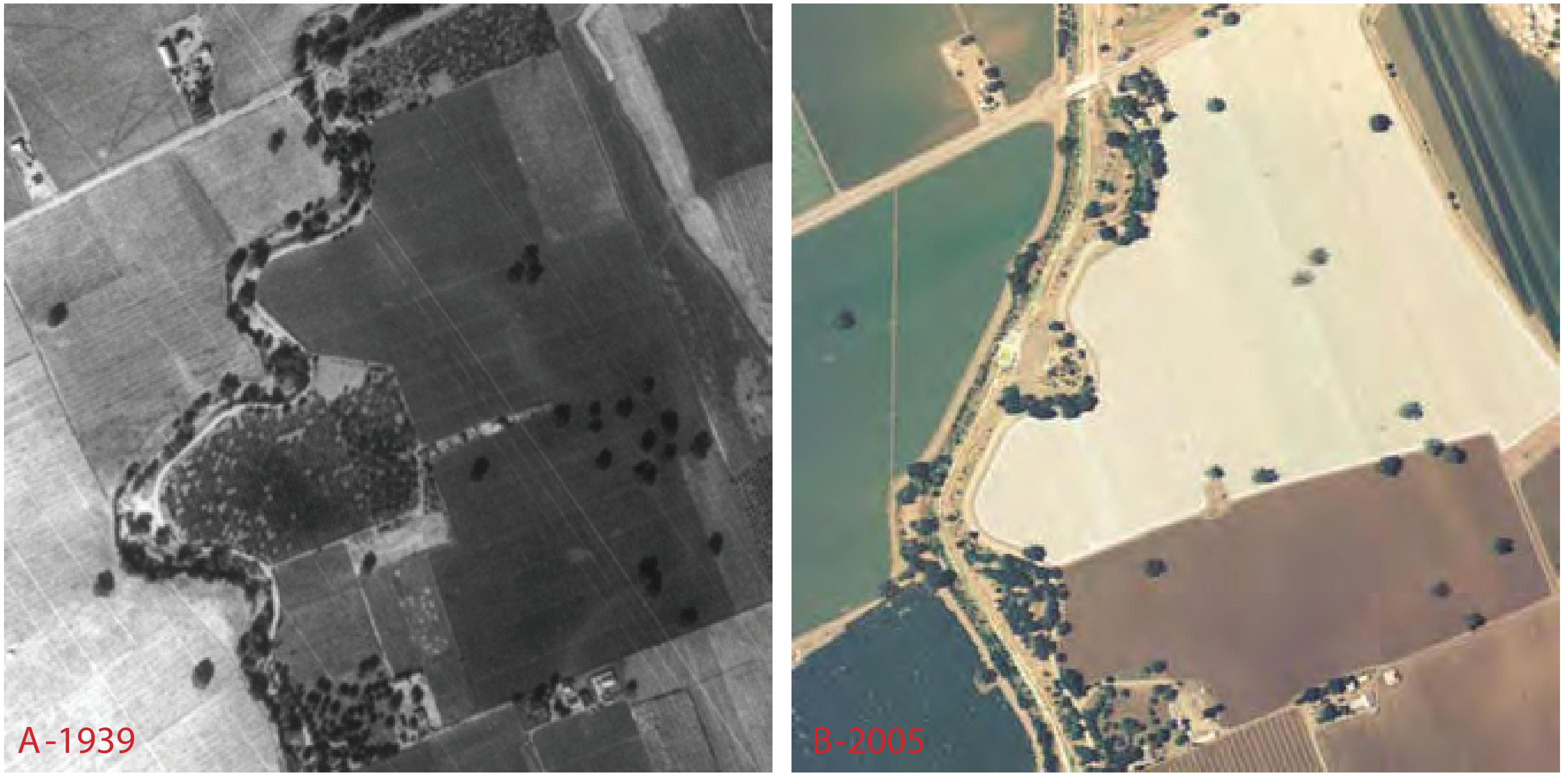
- 〰 Creeks, buried or drained
- Y Water spreads over ground
- ▤ Lakes and ponds
- ▩ Willow grove
- ▤ Freshwater marsh
- ▬ Llagas Creek Study Reach

0 0.5 1

Approx. Scale in Miles

PACIFIC
GEOTECHNICAL
ENGINEERING

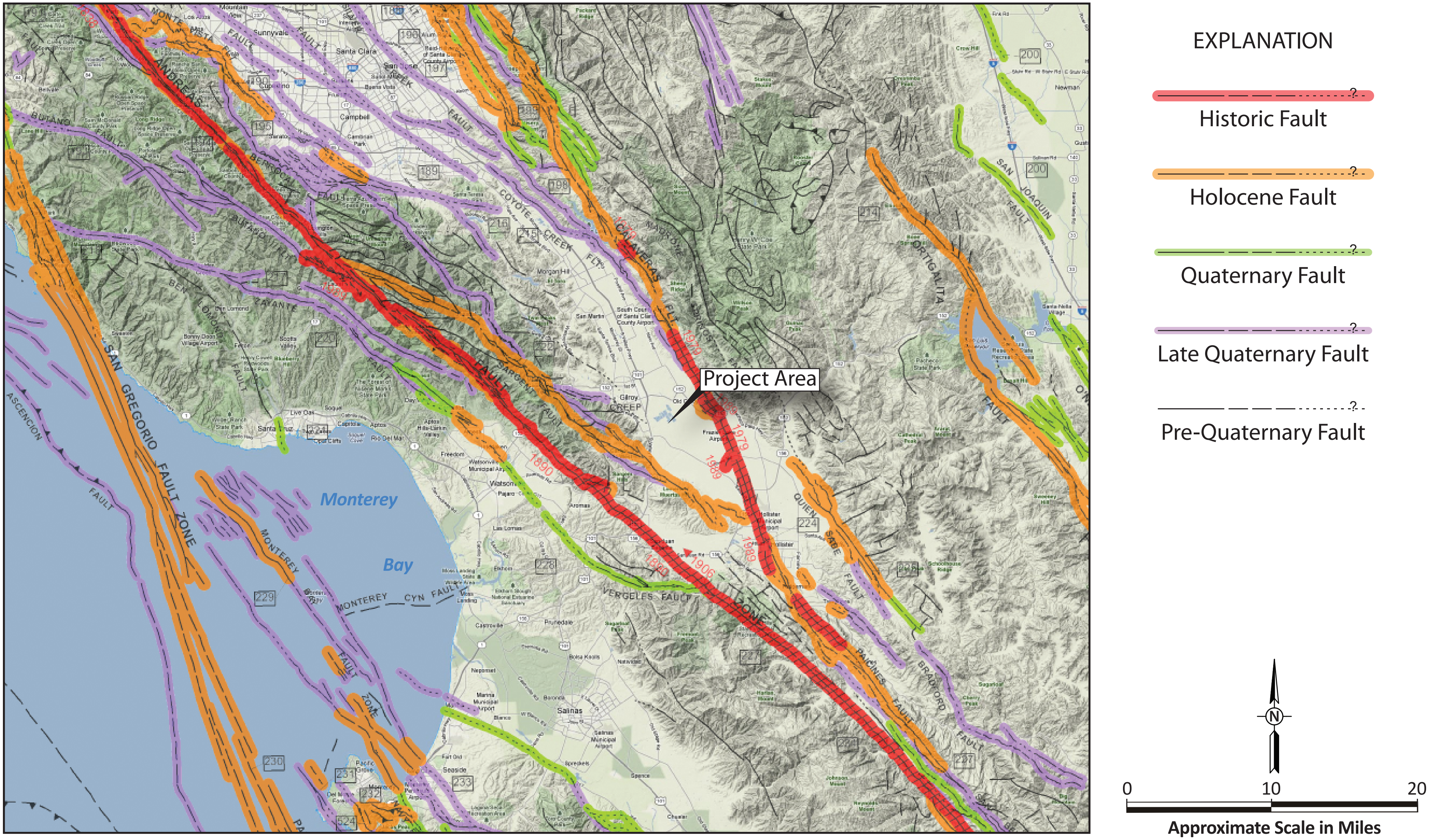
DATE	HISTORIC CREEK GEOMORPHOLOGY MAP	FIGURE
May 2012		5
SCALE	Lower Llagas Flood Control Project Santa Clara County, California	PROJECT
As Shown		2011.0191 Phase 100



Former channel meanders of Llagas Creek. Over 60 km (40 mi) of historical streams (A) have been straightened or rerouted (B). Excavation of Llagas Creek in the early 1970s for gravel to construct Highway 101 and flood benefits produced these isolated oxbows along the current flood control channel (B; USDA 1982). (A: USDA 1939, courtesy of the Science & Engineering Library Map Room, UC Santa Cruz; B: USDA 2005, courtesy of NAIP

(Figures and captions excerpted from Grossinger, et. al., 2008)

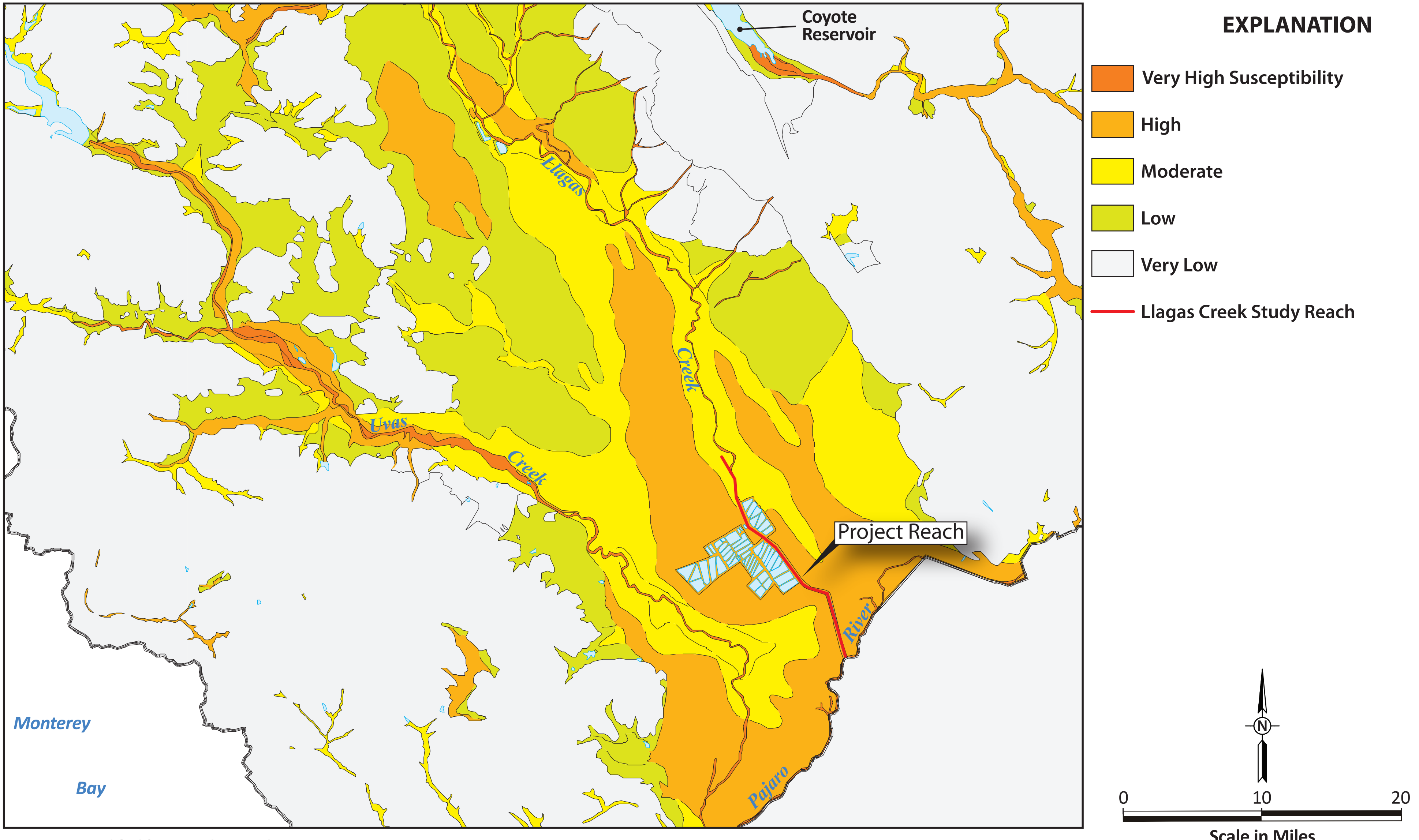
PACIFIC GEOTECHNICAL ENGINEERING	DATE May 2012	HISTORIC MEANDERS OF LLAGAS CREEK	FIGURE 6
	SCALE As Shown	Lower Llagas Flood Control Project Santa Clara County, California	PROJECT 2011.0191 Phase 100



Base Map: Modified from Jennings and Bryant, 2010

PACIFIC
GEOTECHNICAL
ENGINEERING

DATE	REGIONAL FAULT MAP	FIGURE
May 2012		7
SCALE	Lower Llagas Flood Control Project Santa Clara County, California	PROJECT
As Shown		2011.0191 Phase 100



Base Map: Modified from Knudsen, et.al., 2000

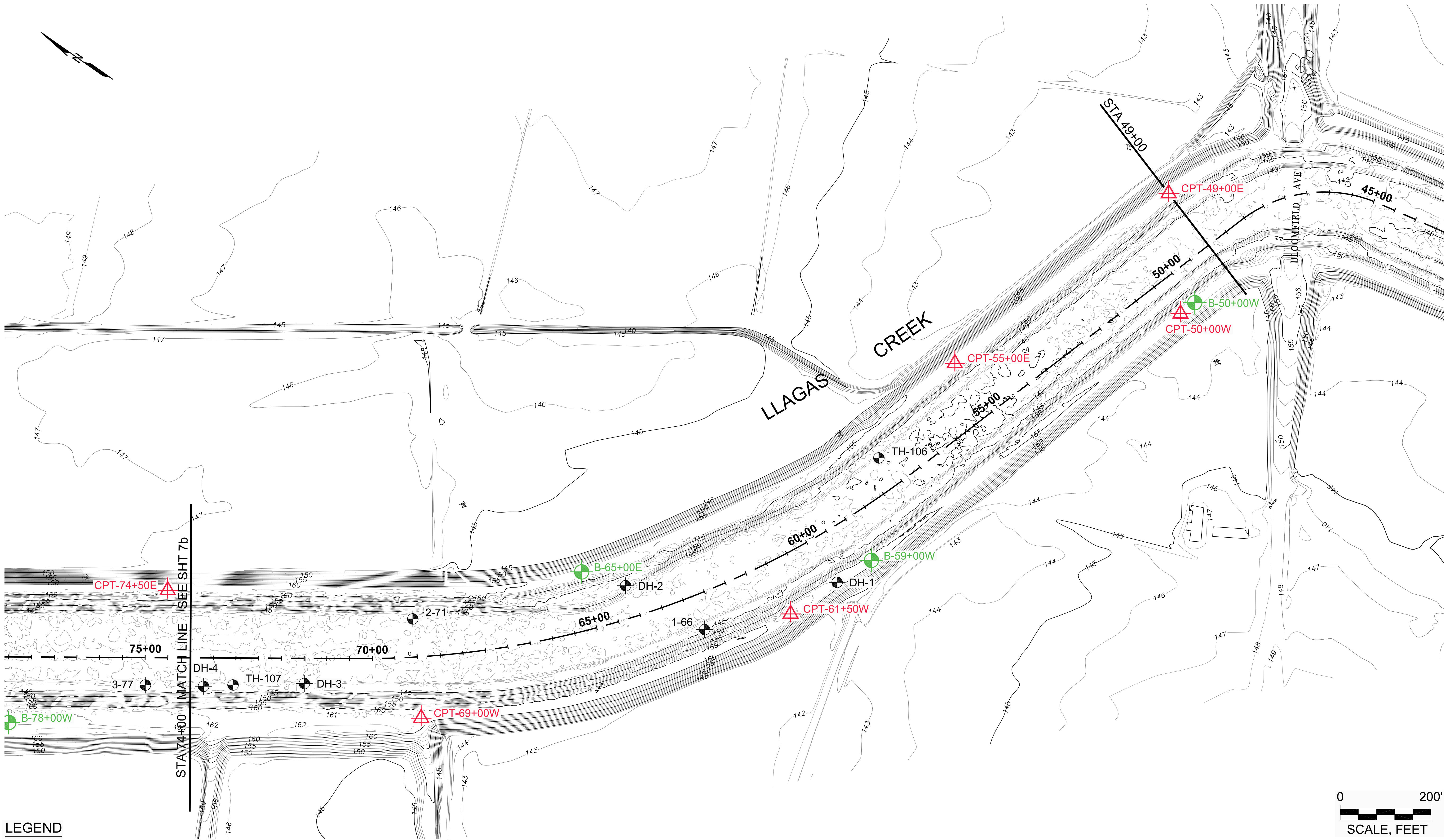
PACIFIC
GEOTECHNICAL
ENGINEERING

DATE	May 2012
SCALE	As Shown

REGIONAL LIQUEFACTION SUSCEPTIBILITY MAP

Lower Llagas Flood Control Project
Santa Clara County, California

FIGURE	8
PROJECT	2011.0191 Phase 100



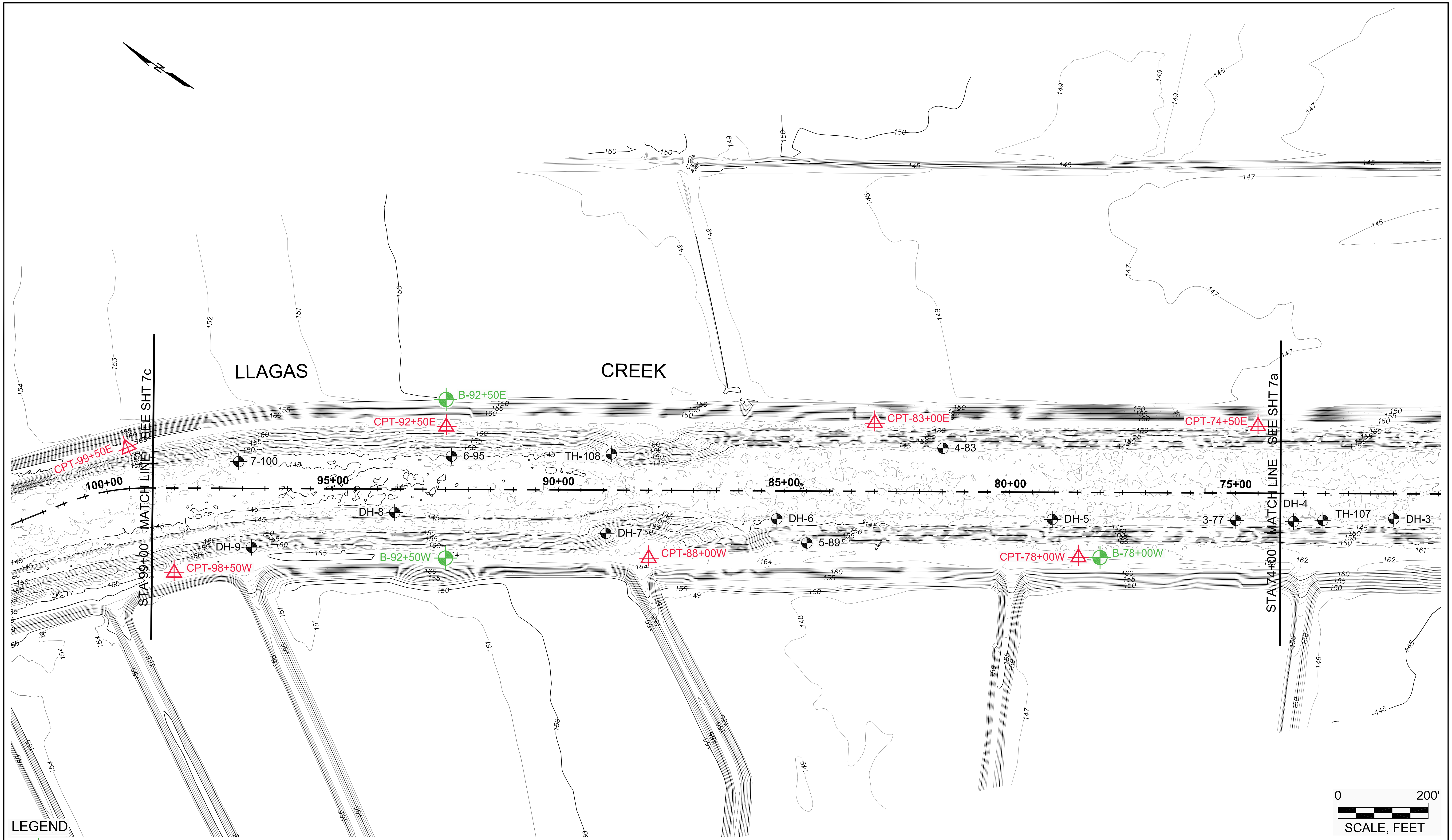
LEGEND

- 🟢 APPROXIMATE LOCATION OF EXPLORATORY BORING
- △ APPROXIMATE LOCATION OF CONE PENETRATION TEST
- 🔵 APPROXIMATE LOCATION OF STAND-PIPE PIEZOMETER
- ◐ APPROXIMATE LOCATION OF EXPLORATION BY OTHERS

SOURCE:
TOPOGRAPHY AND AERIAL IMAGE FILES PROVIDED BY THE SANTA CLARA VALLEY WATER DISTRICT FOR PROJECT USE, DECEMBER 2011.

Oakland • California GEI Consultants	Lower Llagas Creek Capacity Restoration Project GEI Project 115400	SANTA CLARA VALLEY WATER DISTRICT	SITE AND FIELD EXPLORATION PLAN STA 49+00 TO 74+00 (sheet 1 of 5)	04/12/12 FIGURE 9a

9a 04/12/12 PYM



LEGEND

⊕ APPROXIMATE LOCATION OF EXPLORATORY BORING

△ APPROXIMATE LOCATION OF CONE PENETRATION TEST

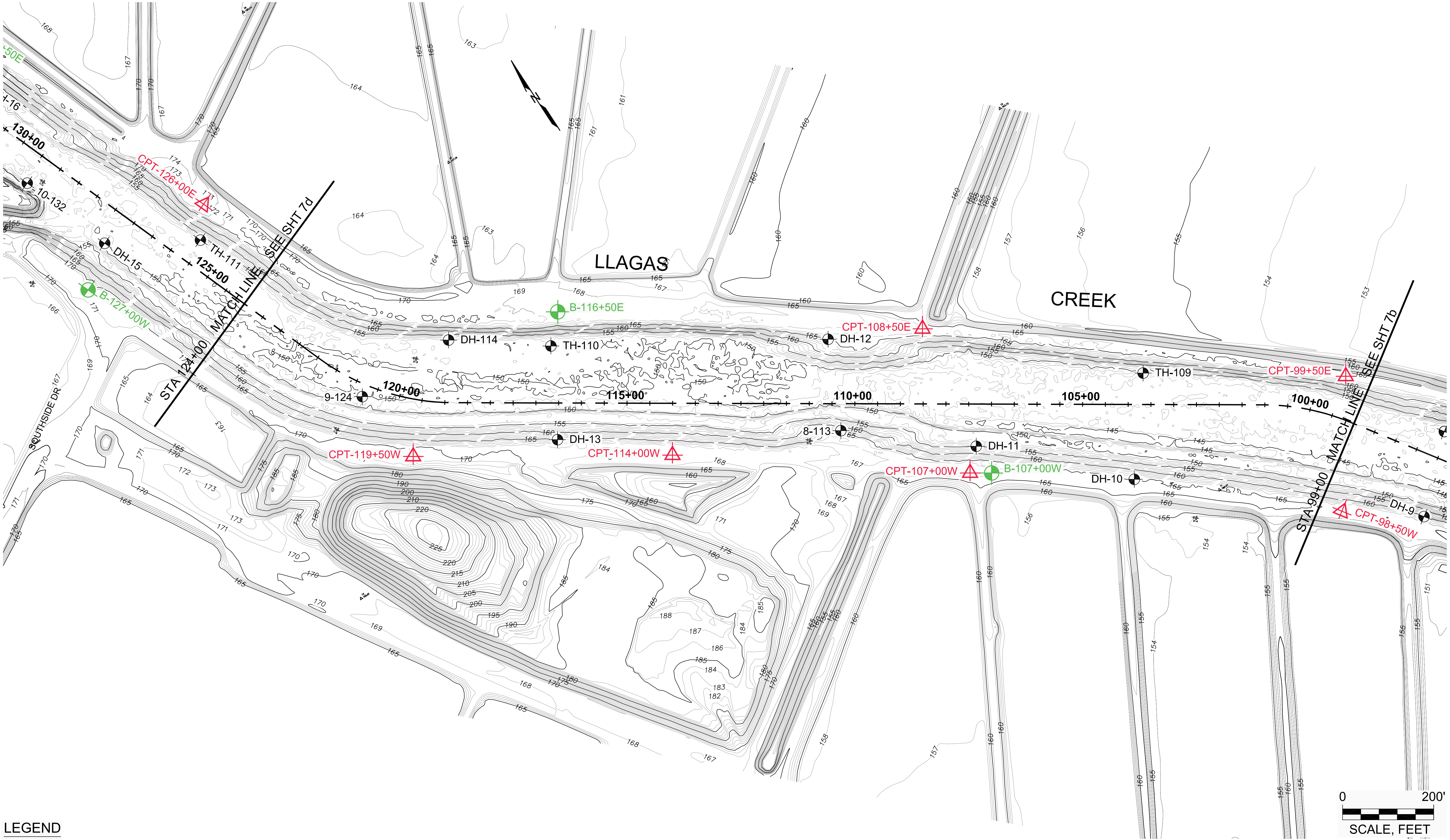
⊕ APPROXIMATE LOCATION OF STAND-PIPE PIEZOMETER

◐ APPROXIMATE LOCATION OF EXPLORATION BY OTHERS

SOURCE:
TOPOGRAPHY AND AERIAL IMAGE FILES PROVIDED BY THE SANTA CLARA VALLEY WATER DISTRICT FOR PROJECT USE, DECEMBER 2011.

Oakland, California GEI Consultants	Lower Llagas Creek Capacity Restoration Project GEI Project 115400	SANTA CLARA VALLEY WATER DISTRICT	SITE AND FIELD EXPLORATION PLAN STA 74+00 TO 99+00 (sheet 2 of 5)	04/12/12 FIGURE 9b

9b 04/12/12 PYM



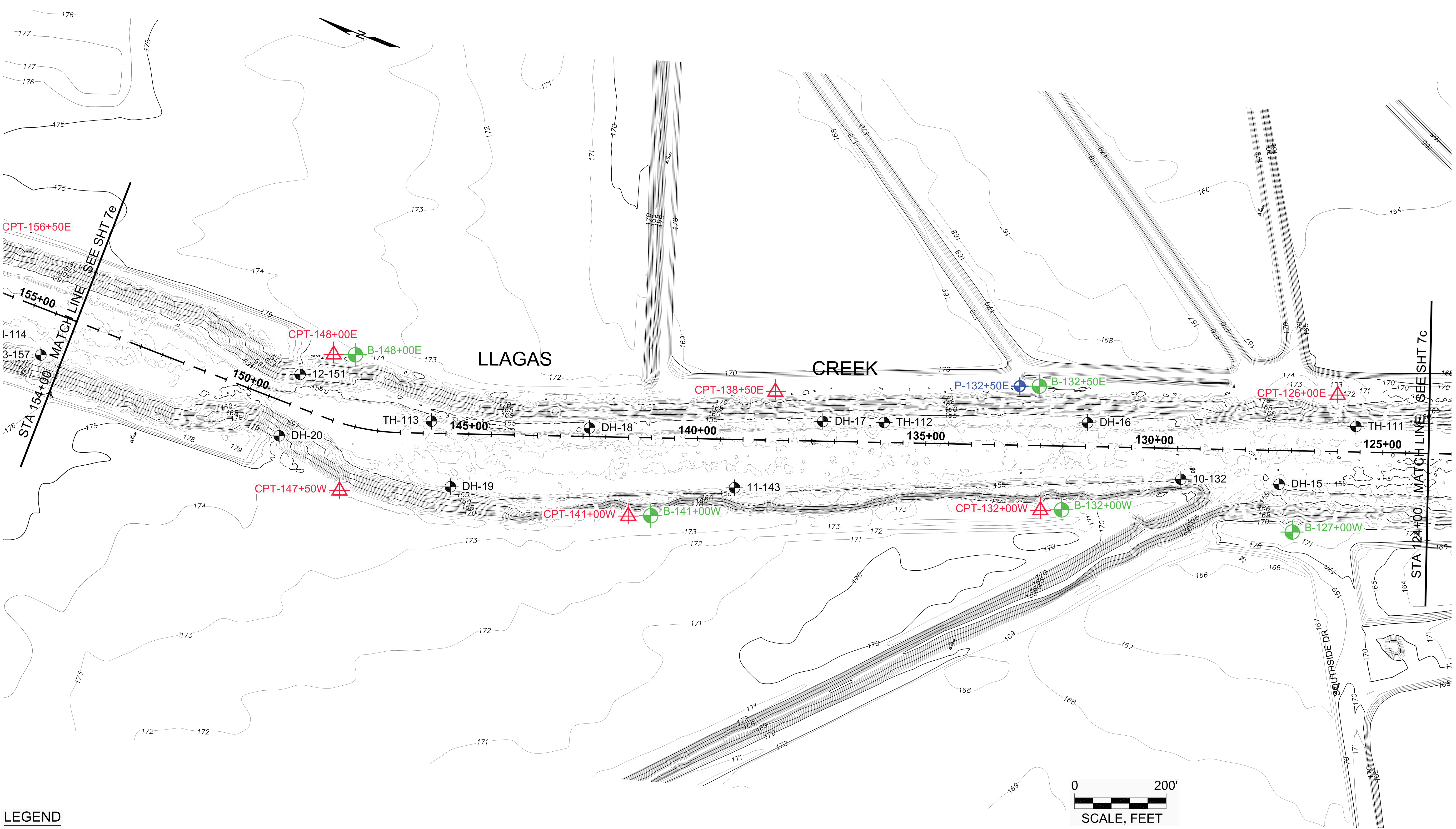
LEGEND

- 🟢 APPROXIMATE LOCATION OF EXPLORATORY BORING
- △ APPROXIMATE LOCATION OF CONE PENETRATION TEST
- 🔵 APPROXIMATE LOCATION OF STAND-PIPE PIEZOMETER
- ◐ APPROXIMATE LOCATION OF EXPLORATION BY OTHERS

SOURCE:
TOPOGRAPHY AND AERIAL IMAGE FILES PROVIDED BY THE SANTA CLARA VALLEY WATER DISTRICT FOR PROJECT USE, DECEMBER 2011.

Oakland, California GEI Consultants	Lower Llagas Creek Capacity Restoration Project GEI Project 115400	SANTA CLARA VALLEY WATER DISTRICT	SITE AND FIELD EXPLORATION PLAN STA 99+00 TO 124+00 (sheet 3 of 5)	04/12/12 FIGURE 9c

9c 04/12/12 PYM



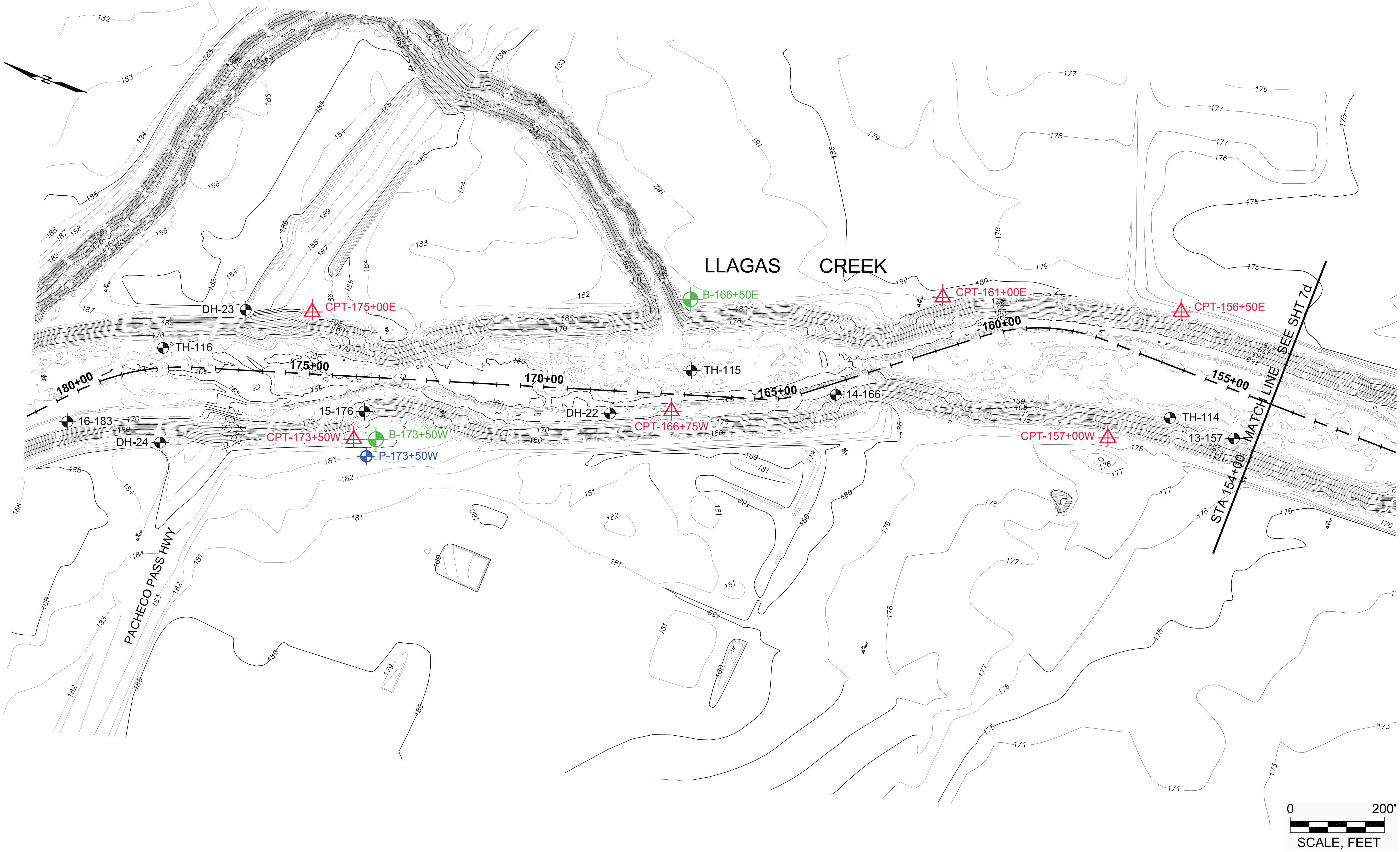
LEGEND

- ⊕ APPROXIMATE LOCATION OF EXPLORATORY BORING
- △ APPROXIMATE LOCATION OF CONE PENETRATION TEST
- ⊕ APPROXIMATE LOCATION OF STAND-PIPE PIEZOMETER
- ◐ APPROXIMATE LOCATION OF EXPLORATION BY OTHERS

SOURCE:
TOPOGRAPHY AND AERIAL IMAGE FILES PROVIDED BY THE SANTA CLARA VALLEY WATER DISTRICT FOR PROJECT USE, DECEMBER 2011.

Oakland California GEI Consultants	Lower Llagas Creek Capacity Restoration Project GEI Project 115400	SANTA CLARA VALLEY WATER DISTRICT	SITE AND FIELD EXPLORATION PLAN STA 124+00 TO 154+00 (sheet 4 of 5)	04/12/12 FIGURE 9d

9d 04/12/12 PYM



LEGEND

- APPROXIMATE LOCATION OF EXPLORATORY BORING
- APPROXIMATE LOCATION OF CONE PENETRATION TEST
- APPROXIMATE LOCATION OF STAND-PIPE PIEZOMETER
- APPROXIMATE LOCATION OF EXPLORATION BY OTHERS

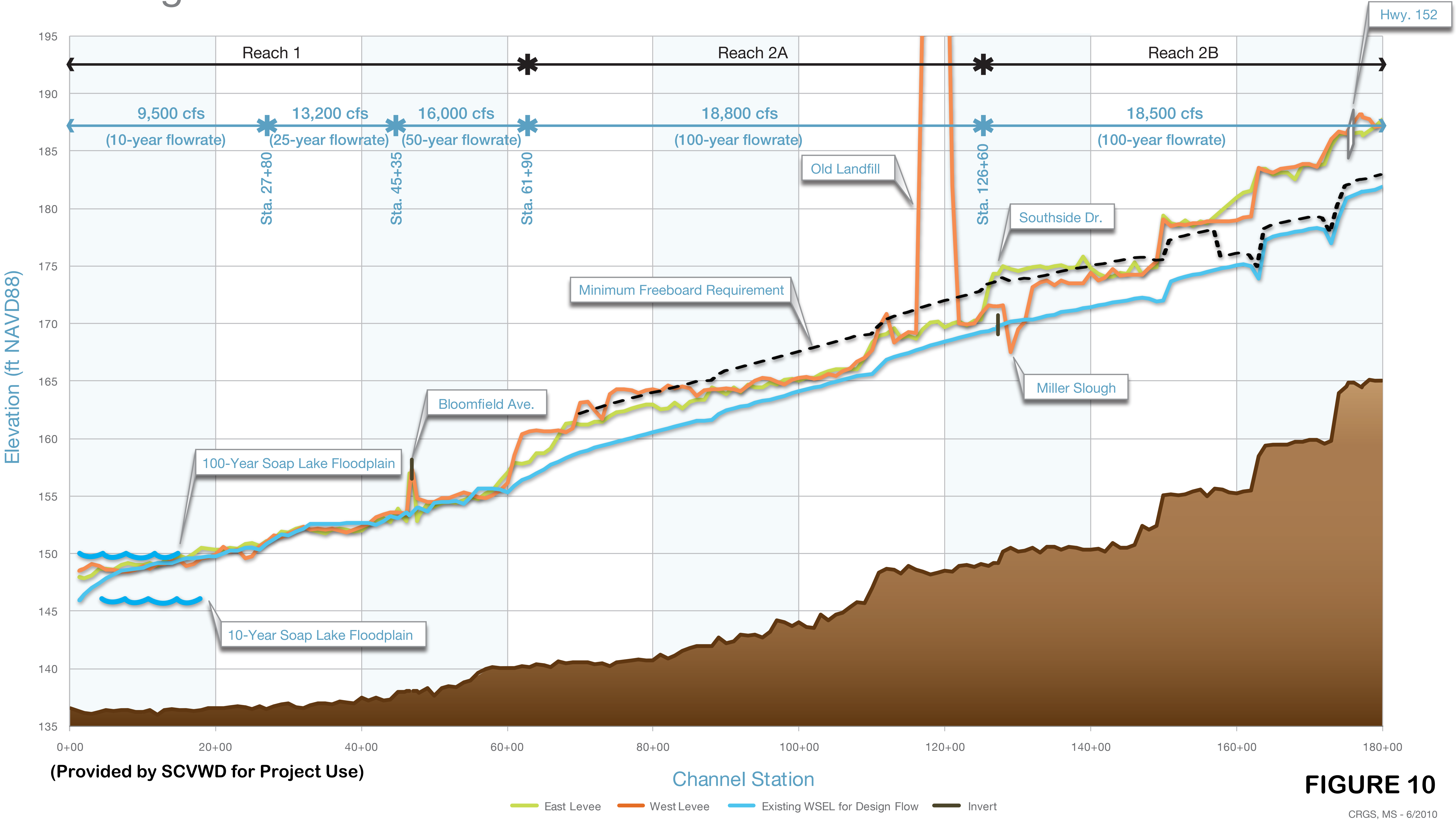
SOURCE:
TOPOGRAPHY AND AERIAL IMAGE FILES PROVIDED BY THE SANTA CLARA VALLEY WATER DISTRICT FOR PROJECT USE, DECEMBER 2011.

Oakland • California GEI Consultants	Lower Llagas Creek Capacity Restoration Project GEI Project 115400	SANTA CLARA VALLEY WATER DISTRICT	SITE AND FIELD EXPLORATION PLAN STA 154+00 TO 180+00 (sheet 5 of 5)	04/12/12 FIGURE 9e

9e 04/12/12 PYM

Lower Llagas Creek Capacity Restoration Project

Design Flowrates



(Provided by SCVWD for Project Use)

FIGURE 10

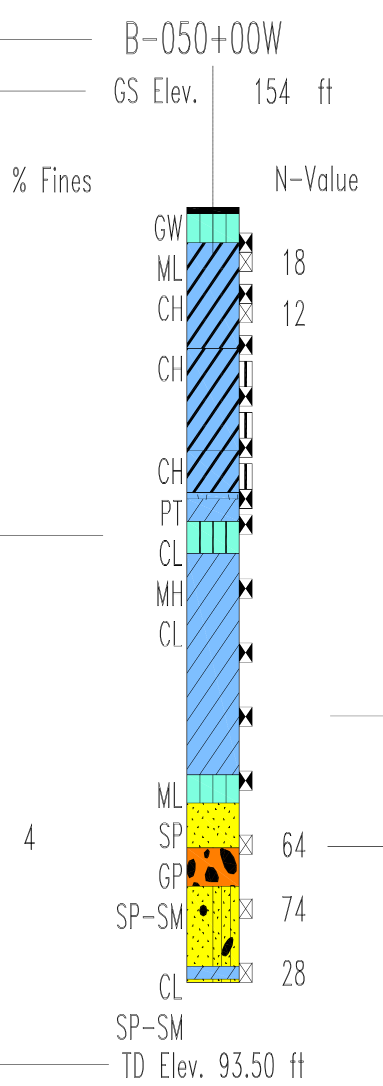
CRGS, MS - 6/2010

BORING LOG LEGEND

Exploration Number

Ground Surface Elev
at Top of Boring

Percent Fines (Material
passing No. 200 sieve)



USCS Symbol

Sampler Symbols

Blow Counts (Blows/12in.)
Raw, uncorrected. See boring log for details

"TOTAL DEPTH"
(Elevation at base of boring)

SOIL BORING LEGEND
BASED ON UNIFIED SOIL CLASSIFICATION SYSTEM (ASTM D2487)

GROUP SYMBOLS AND NAMES

Graphic	Group Names	Graphic	Group Names
▨	Lean Clay (CL)	▨	Lean Clay with Sand (CL)
▨	Fat Clay (CH)	▨	Sandy Silty Clay (CL-ML)
▨	Sandy Lean Clay (CL)	▨	Clayey Silt (CL-ML)
▥	Silt (ML)	▥	Silt with Sand (ML)
▥	Sandy Silt (ML)	▥	Elastic Silt (MH)
▒	Poorly Graded Sand (SP)	▒	Poorly Graded Sand with Gravel (SP)
▒	Poorly Graded Sand with Silt (SP-SM)	▒	Poorly Graded Sand with Silt and Gravel (SP-SM)
▒	Well-Graded Sand (SW)	▒	Well-Graded Sand with Gravel (SW)
▒	Well-Graded Sand with Silt (SW-SM)	▒	Silty Sand (SM)
▒	Poorly Graded Gravel with Sand (GP)	▒	Poorly Graded Gravel with Clay and Sand (GP-GC)
▒	Well-Graded Gravel (GW)	▒	Well-Graded Gravel with Silt (GW-GM)

SAMPLER GRAPHIC SYMBOLS

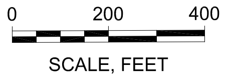
☒	Standard Penetration Test (1.4 in. ID)
⧗	Modified California (2.0 in. ID)
▯	Shelby Tube (2.87 in. or 2.37 in. ID)

LEGEND

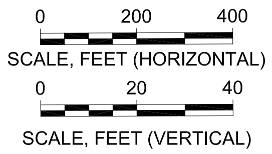
⊕	APPROXIMATE LOCATION OF EXPLORATORY BORING
△	APPROXIMATE LOCATION OF CONE PENETRATION TEST
⊕	APPROXIMATE LOCATION OF EXPLORATION BY OTHERS
– – – – –	WEST LEVEE CREST
------------	EAST LEVEE CREST
– – – – –	WEST LEVEE TOE
------------	EAST LEVEE TOE
———	CREEK INVERT
—— - - - ——	WATER SURFACE

SOURCE:
TOPOGRAPHY AND AERIAL IMAGE FILES PROVIDED BY THE SANTA CLARA VALLEY WATER DISTRICT FOR PROJECT USE, DECEMBER 2011.

PLAN SCALE



PROFILE SCALE



NOTES

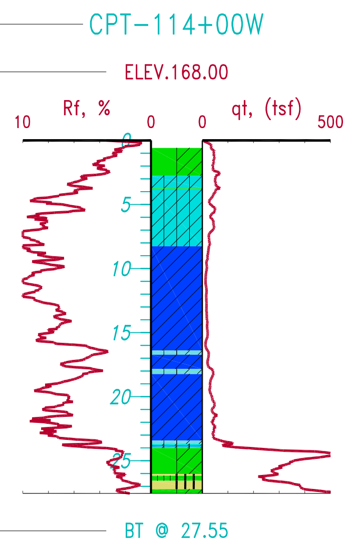
1. LOCATIONS OF EXPLORATIONS SHOWN ARE APPROXIMATE.
2. LOGS REPRESENT GENERAL SOIL CONDITIONS OBSERVED AT THE POINT OF EXPLORATION.
3. THE BORING LOG LEGEND SHOWN APPLIES TO CAL ENGINEERING & GEOLOGY 2012 BORINGS (BXX+XX). CAUTION IS ADVISED IN USING THE LEGEND FOR INTERPRETATION OF OTHER EXPLORATIONS. SEE FULL BORING LOGS IN APPENDIX C.
4. THE CPT LEGEND SHOWN APPLIES TO CAL ENGINEERING & GEOLOGY 2012 CPTS (CPTXX+XX). CAUTION IS ADVISED IN USING THE LEGEND FOR INTERPRETATION OF OTHER EXPLORATIONS. SEE FULL CPT LOGS IN APPENDIX C.
5. LINES SEPARATING STRATA ON LOGS REPRESENT APPROXIMATE BOUNDARIES ONLY. ACTUAL TRANSITIONS MAY BE GRADUAL.
6. NO WARRANTY IS PROVIDED AS TO THE CONTINUITY OF SOIL CONDITIONS BETWEEN INDIVIDUAL SAMPLE LOCATIONS.
7. CPT AND BORING LOCATIONS WERE RECORDED BY CAL ENGINEERING & GEOLOGY USING A HANDHELD GLOBAL POSITIONING SYSTEM (GPS) UNIT WITH A HORIZONTAL ACCURACY OF ABOUT 20 FEET. LATITUDE AND LONGITUDE COORDINATES OF BORING LOCATIONS WERE CONVERTED TO NORTHING AND EASTING COORDINATES BASED ON THE CALIFORNIA COORDINATE SYSTEM ZONE II (1983 NORTH AMERICAN DATUM). THE LOCATIONS OF BORINGS PROVIDED BY CAL ENGINEERING & GEOLOGY WERE USED TO ESTIMATE THE GROUND SURFACE ELEVATIONS [NORTH AMERICAN VERTICAL DATUM, 1988 (NAVD88)] DERIVED FROM LIDAR DATA.
8. THE PROJECT DESIGN WATER SURFACE ELEVATION PROFILE SHOWN WAS PROVIDED BY WOOD SANTA CLARA VALLEY WATER DISTRICT FOR PROJECT USE.
9. ELEVATIONS ARE REFERENCED TO NAVD 88.

CPT LEGEND

qt = NORMALIZED TIP RESISTANCE, tsf
Rf = NORMALIZED FRICTION RATIO, %
(MAX Rf FOR PROFILE SET AT 10%, MAX qt FOR PROFILE SET AT 500 tsf. SEE CPT LOGS FOR DETAILED RESULTS)

Exploration Number

Ground Surface Elevation
at Top of CPT

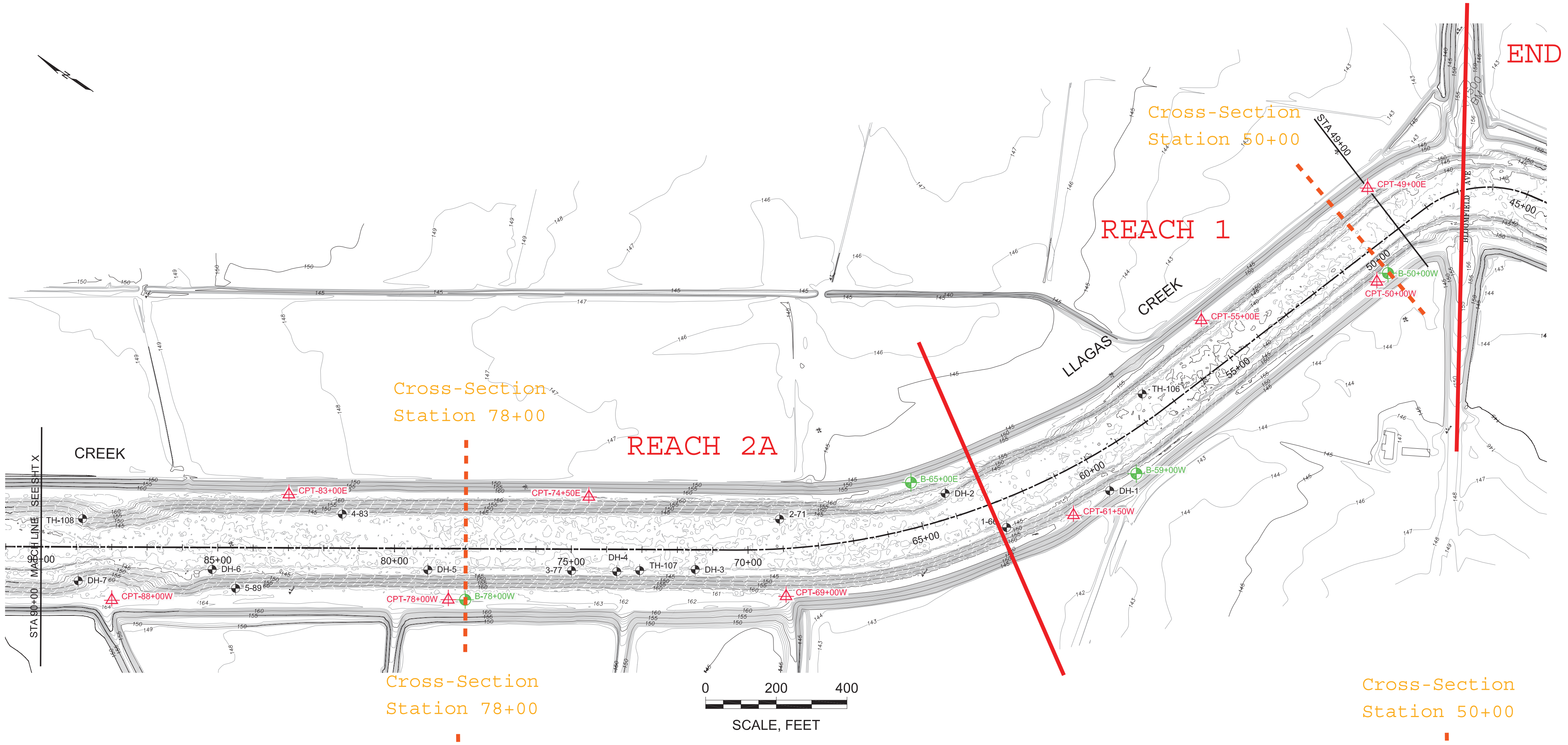


Total Depth of CPT

SBTn	CPT MATERIAL GRAPHICS	
1	▨	Sensitive, Fine Grained Soils
2	▨	Organic Soils, Peats
3	▨	Clays–Clay to Silty Clay
4	▨	Silt Mixtures–Clay Silt to Silty Clay
5	▥	Sand Mixtures–Silty Sand to Sandy Silt
6	▥	Sands–Clean Sand to Silty Sand
7	▨	Gravelly Sand to Sand
8	▨	Very Stiff Clay to Clayey Sand
9	▨	Very Stiff Fine Grained Soils

* BASED ON ROBERTSON et. al. (1990)

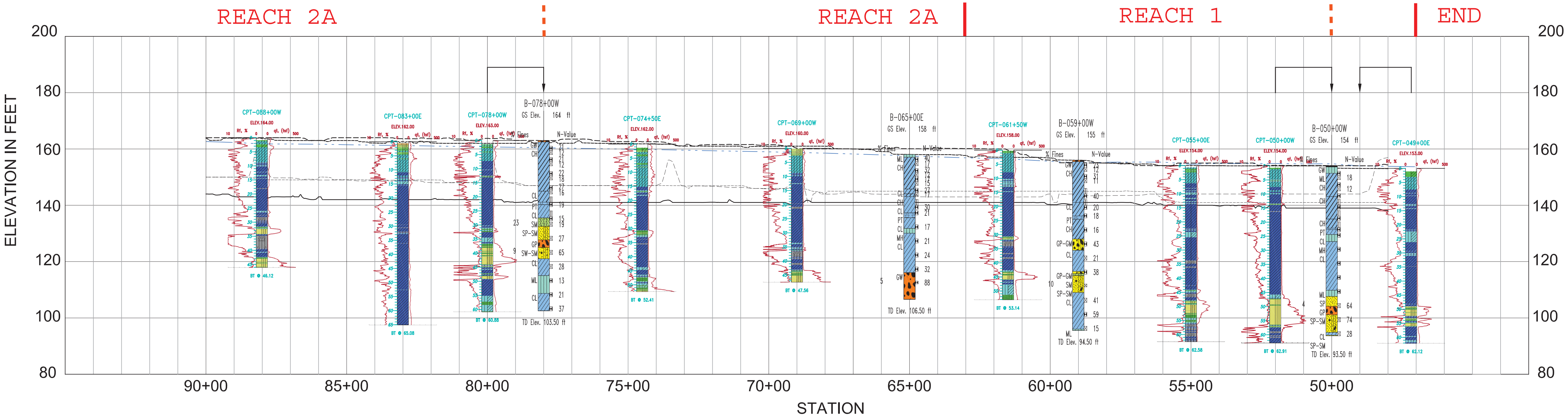
Oakland • California GEI Consultants	Lower Llagas Creek Capacity Restoration Project GEI Project 115400	SANTA CLARA VALLEY WATER DISTRICT	SUBSURFACE PROFILE COVER SHEET	02/02/12 FIGURE 11



LEGEND

- APPROXIMATE LOCATION OF EXPLORATORY BORING
- APPROXIMATE LOCATION OF CONE PENETRATION TEST
- APPROXIMATE LOCATION OF EXPLORATION BY OTHERS

SOURCE:
TOPOGRAPHY AND AERIAL IMAGE FILES PROVIDED BY THE SANTA CLARA VALLEY WATER DISTRICT FOR PROJECT USE, DECEMBER 2011.



LEGEND:

— — — —	WEST LEVEE CREST
------------	EAST LEVEE CREST
– – – –	WEST LEVEE TOE
············	EAST LEVEE TOE
———	CREEK INVERT
— · · —	WATER SURFACE

0 200 400
SCALE, FEET (HORIZONTAL)

0 20 40
SCALE, FEET (VERTICAL)

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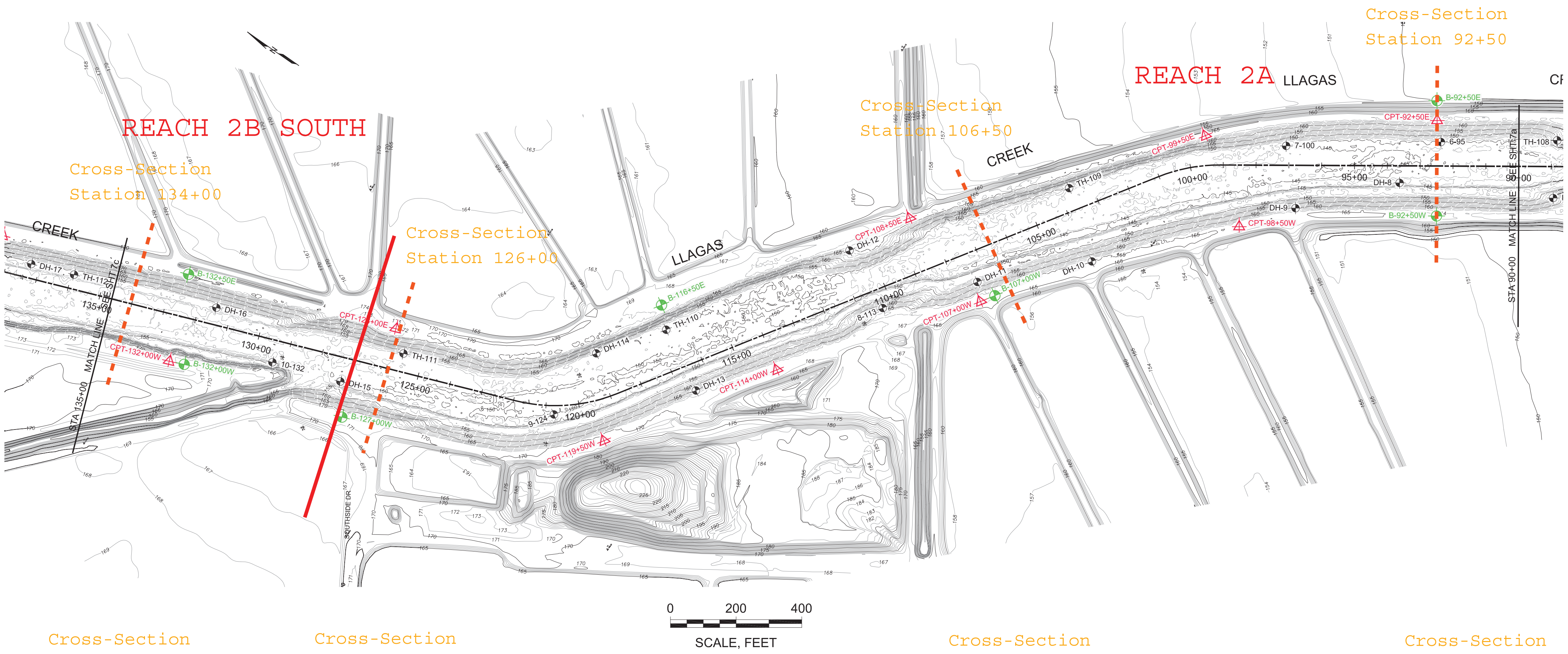
GEI Project 115400

SANTA CLARA VALLEY WATER DISTRICT

SUBSURFACE PROFILE
PLAN STA 48+00 TO 90+00
(Sheet 1 of 3)

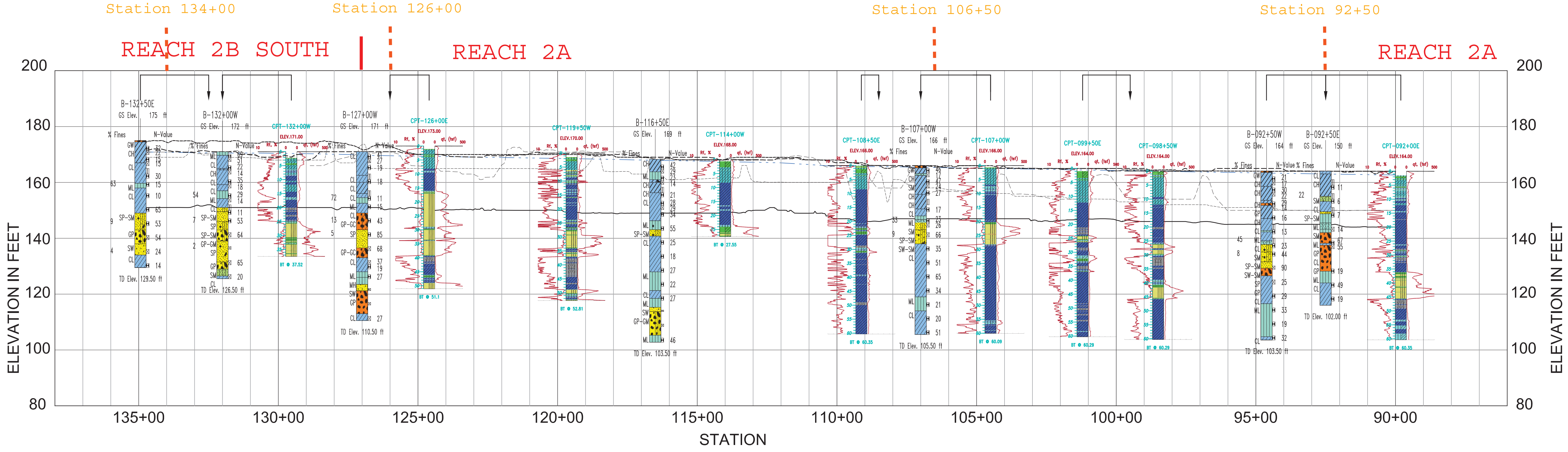
FIGURE
12



LEGEND

- ● APPROXIMATE LOCATION OF EXPLORATORY BORING
- △ APPROXIMATE LOCATION OF CONE PENETRATION TEST
- ● APPROXIMATE LOCATION OF EXPLORATION BY OTHERS

SOURCE:
TOPOGRAPHY AND AERIAL IMAGE FILES PROVIDED BY THE SANTA CLARA VALLEY WATER DISTRICT FOR PROJECT USE, DECEMBER 2011.



LEGEND:

- - - - - -	WEST LEVEE CREST
------------	EAST LEVEE CREST
- - - - - -	WEST LEVEE TOE
....	EAST LEVEE TOE
———	CREEK INVERT
— · · —	WATER SURFACE

0 200 400
SCALE, FEET (HORIZONTAL)

0 20 40
SCALE, FEET (VERTICAL)

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Lower Llagas Creek Capacity Restoration Project

GEI Project 115400

SANTA CLARA VALLEY WATER DISTRICT

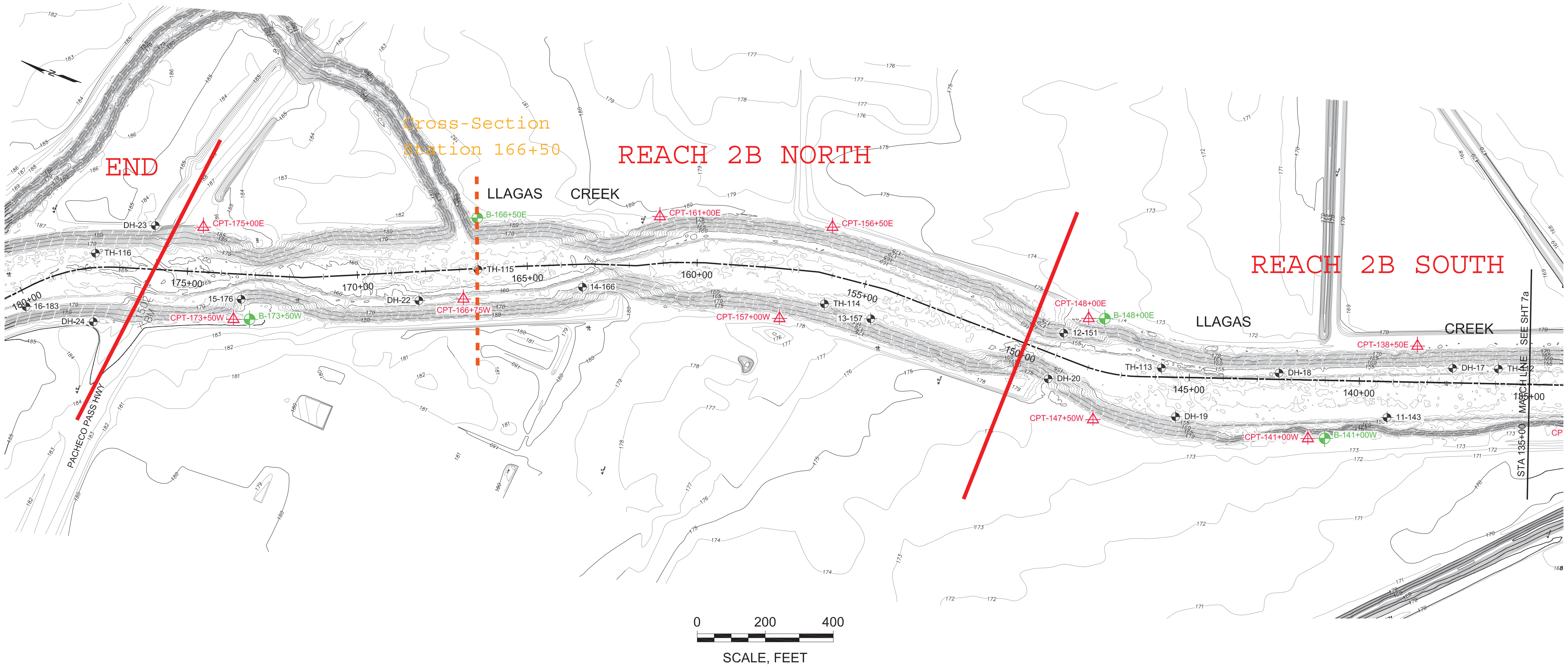
SUBSURFACE PROFILE
PLAN STA 90+00 TO 135+00
(Sheet2 of 3)

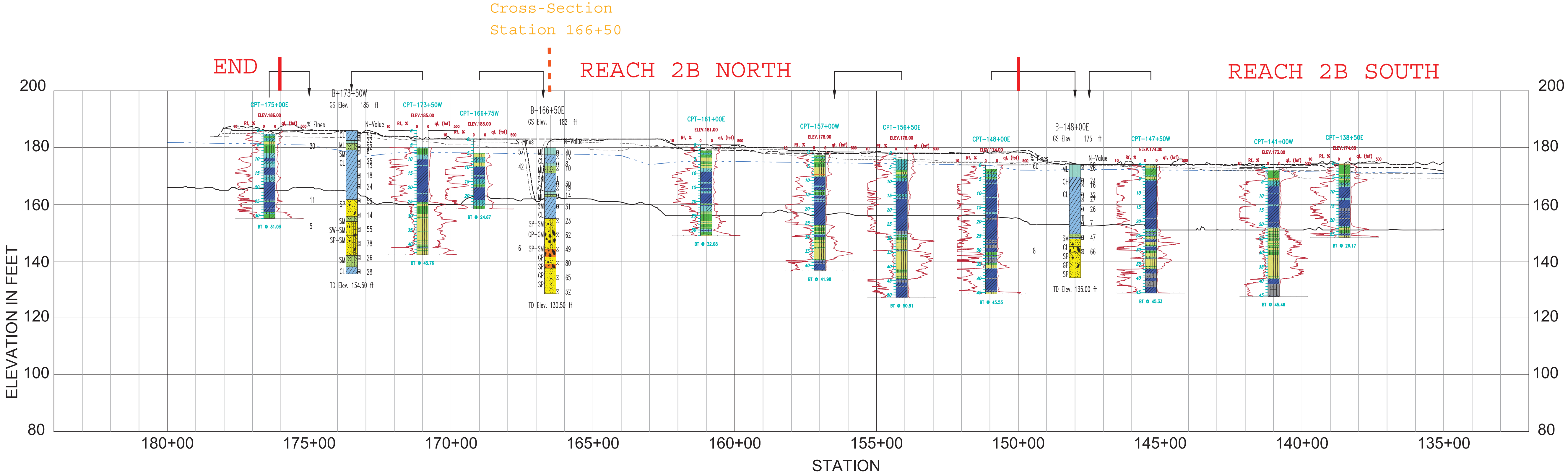
FIGURE
13

LEGEND

- APPROXIMATE LOCATION OF EXPLORATORY BORING
- APPROXIMATE LOCATION OF CONE PENETRATION TEST
- APPROXIMATE LOCATION OF EXPLORATION BY OTHERS

SOURCE:
TOPOGRAPHY AND AERIAL IMAGE FILES PROVIDED BY THE SANTA CLARA VALLEY WATER DISTRICT FOR PROJECT USE, DECEMBER 2011.





LEGEND:

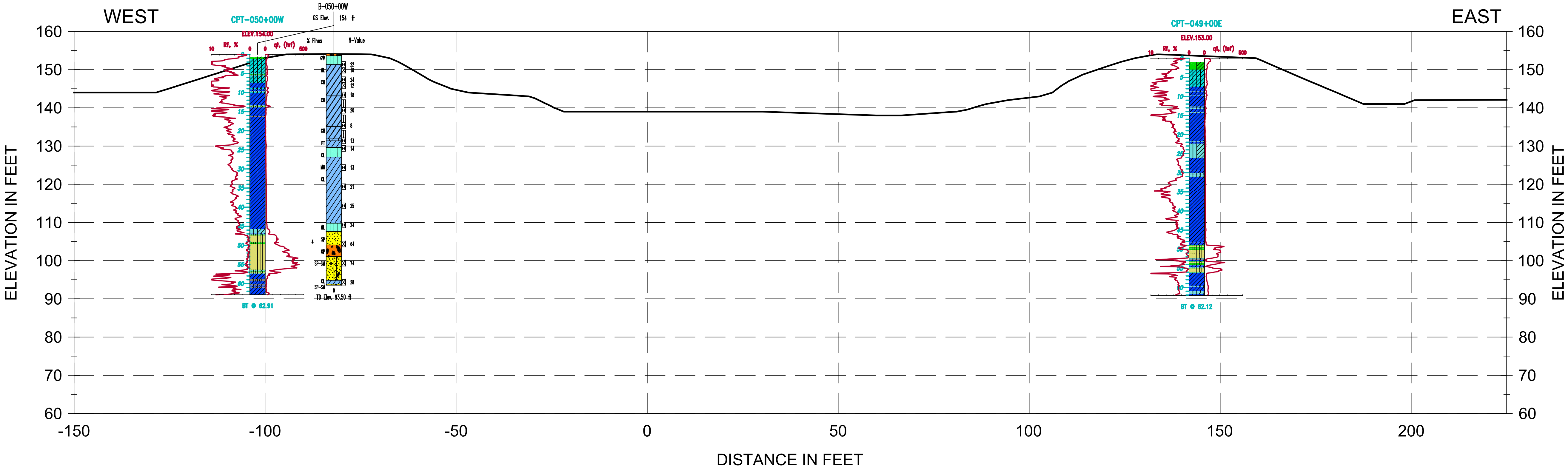
– – – – – –	WEST LEVEE CREST
- - - - - - - -	EAST LEVEE CREST
– – – – – –	WEST LEVEE TOE
- - - - - - - -	EAST LEVEE TOE
———	CREEK INVERT
– · – · –	WATER SURFACE

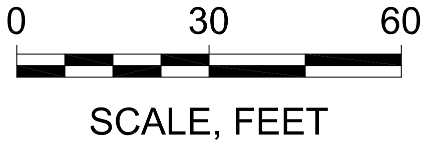
0 200 400
SCALE, FEET (HORIZONTAL)

0 20 40
SCALE, FEET (VERTICAL)

Oakland • California GEI Consultants	Lower Llagas Creek Capacity Restoration Project GEI Project 115400	SANTA CLARA VALLEY WATER DISTRICT	SUBSURFACE PROFILE PLAN STA 135+00 TO 180+00 (Sheet 3 of 3)	FIGURE 14

CHANNEL CROSS-SECTION
STATION 50+00
(LOOKING UPSTREAM)





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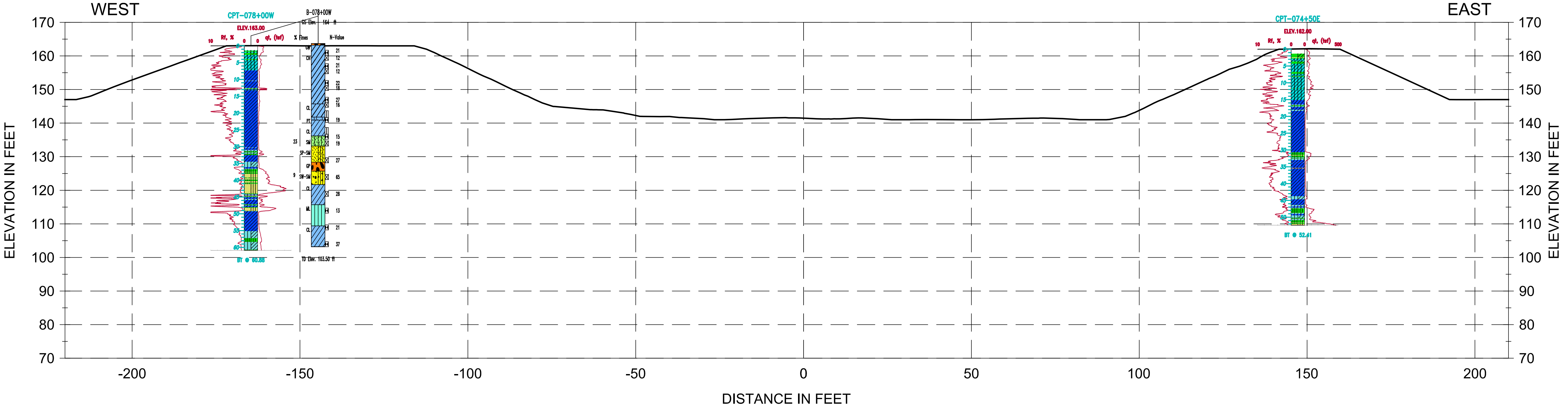
SANTA CLARA VALLEY WATER DISTRICT

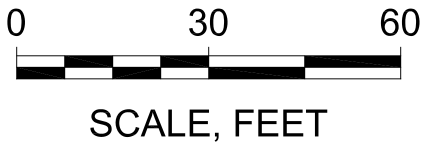
CHANNEL CROSS-SECTION STATION 50+00

02/02/12

FIGURE 15

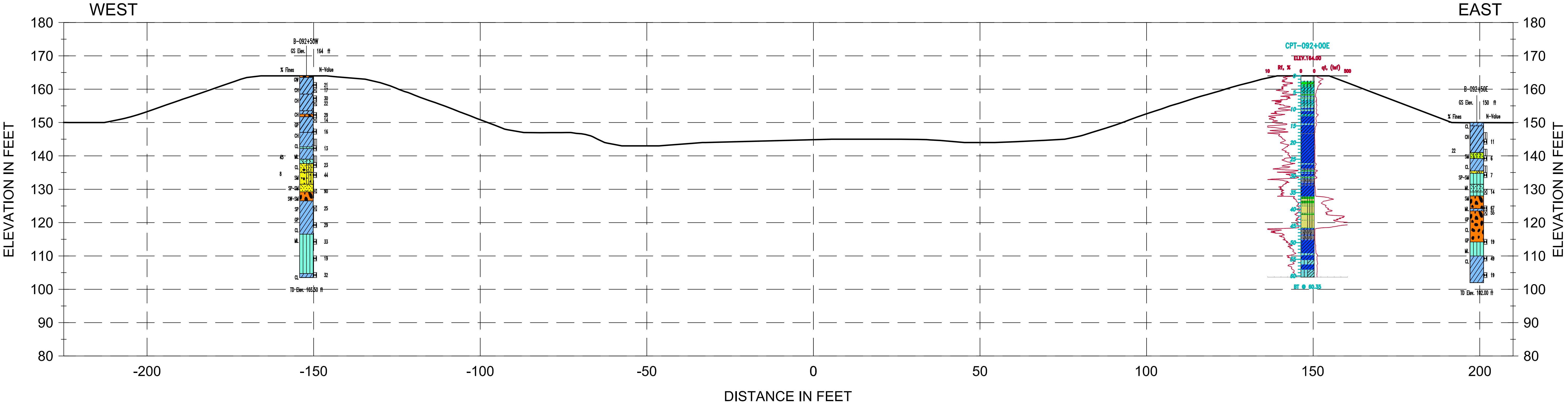
CHANNEL CROSS-SECTION
STATION 78+00
(LOOKING UPSTREAM)





Oakland California GEI Consultants	Lower Llagas Creek Capacity Restoration Project GEI Project 115400	SANTA CLARA VALLEY WATER DISTRICT	CHANNEL CROSS-SECTION STATION 78+00	02/02/12 FIGURE 16

CHANNEL CROSS-SECTION
STATION 92+50
(LOOKING UPSTREAM)



0 30 60

SCALE, FEET

Oakland
California
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Lower Llagas Creek Capacity Restoration Project

GEI Project 115400

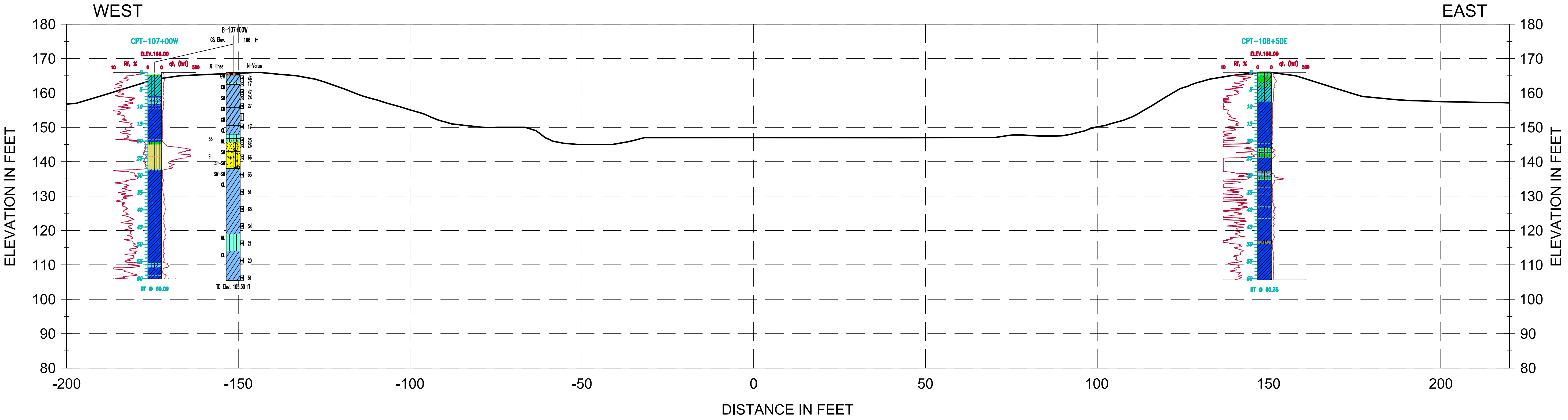
SANTA CLARA VALLEY WATER DISTRICT

CHANNEL CROSS-SECTION
STATION 92+50

02/02/12

FIGURE
17

CHANNEL CROSS-SECTION
STATION 106+50
(LOOKING UPSTREAM)



0 30 60

SCALE, FEET

Oakland
California
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GEI Project 115400

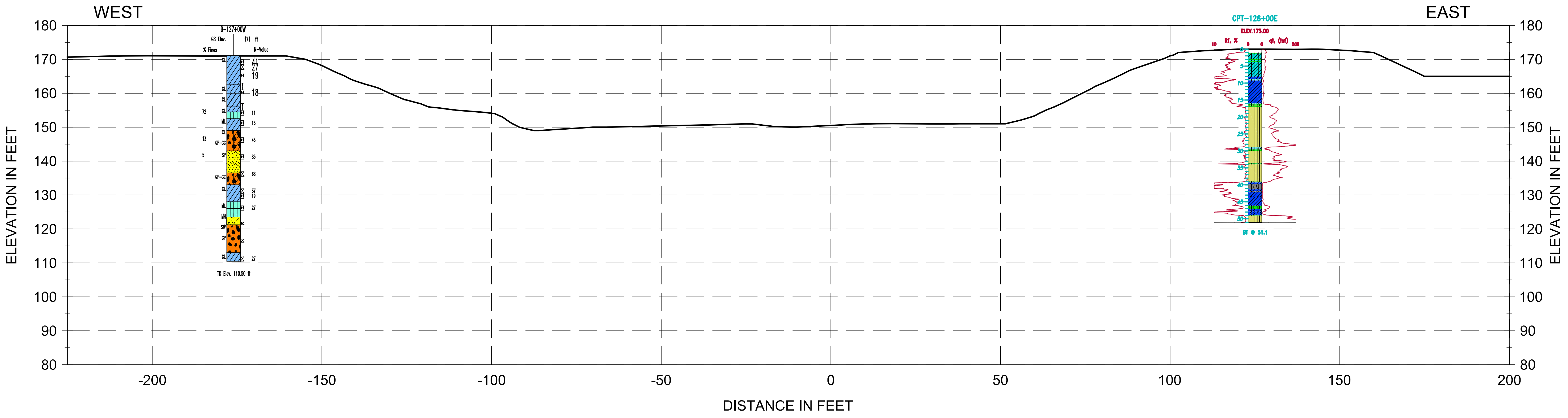
SANTA CLARA VALLEY WATER DISTRICT

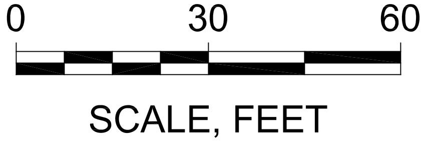
CHANNEL CROSS-SECTION
STATION 106+50

02/02/12

FIGURE
18

CHANNEL CROSS-SECTION
STATION 126+00
(LOOKING UPSTREAM)





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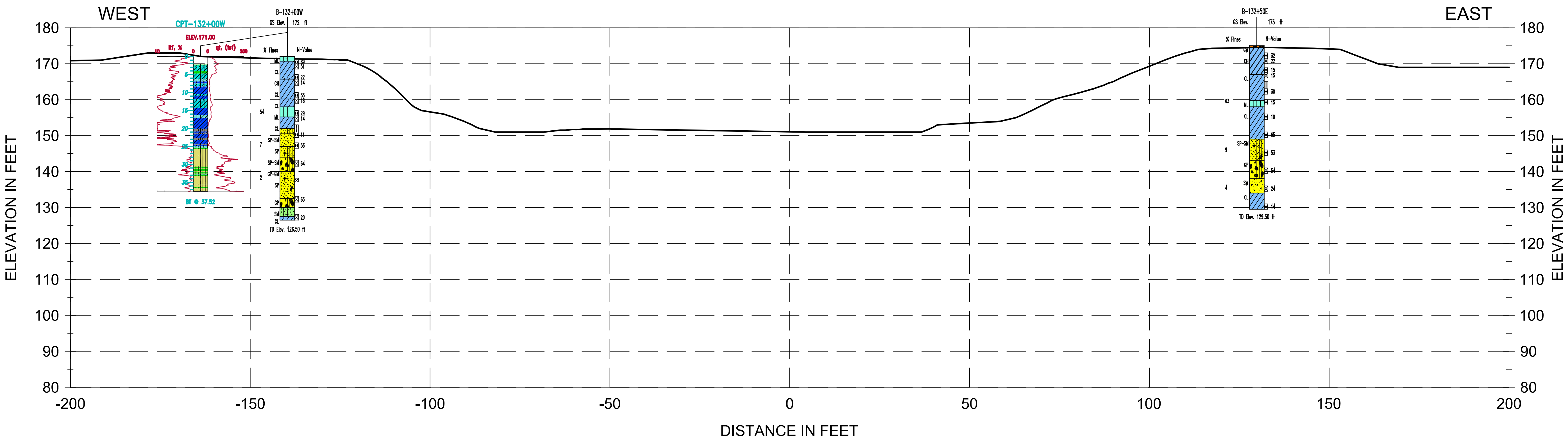
SANTA CLARA VALLEY WATER DISTRICT

CHANNEL CROSS-SECTION
STATION 126+00

02/02/12

FIGURE
19

CHANNEL CROSS-SECTION
STATION 134+00
(LOOKING UPSTREAM)



0 30 60

SCALE, FEET

Oakland
California
GEI Consultants

Lower Llagas Creek Capacity Restoration Project

GEI Project 115400

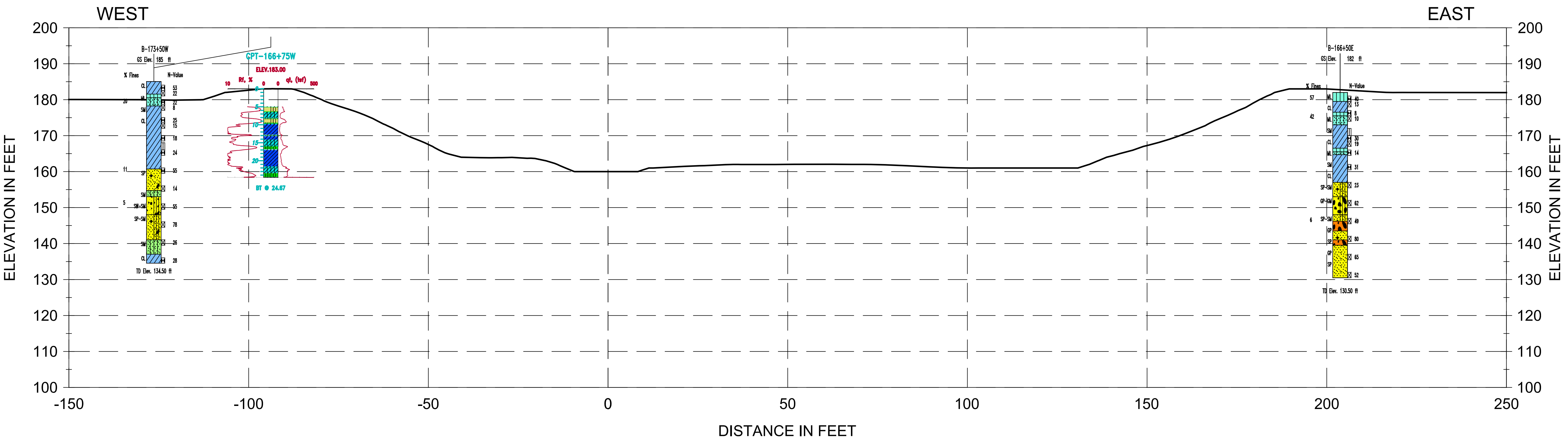
SANTA CLARA VALLEY WATER DISTRICT

CHANNEL CROSS-SECTION
STATION 134+00

02/02/12

FIGURE
20

CHANNEL CROSS-SECTION
STATION 166+50
(LOOKING UPSTREAM)



0 30 60

SCALE, FEET

Oakland
•
California
GEI Consultants

Lower Llagas Creek Capacity Restoration Project

GEI Project 115400

SANTA CLARA VALLEY WATER DISTRICT

CHANNEL CROSS-SECTION
STATION 166+50

02/02/12

FIGURE
21

Tables

Table 1 – Field Exploration Locations Summary

Table 2 – Lower Llagas Creek Existing Conditions Freeboard Table

Table 3 – Field Exploration Subsurface Data Summary

Table 4 – Geotechnical Analyses Results

Table 1 - Field Exploration Locations Summary
Santa Clara Valley Water District
Lower Llagas Creek Capacity Restoration Project

Investigation ID*	Approximate Ground Surface Elevation (Feet, NAVD 88)	Northing	Westing	Levee Location
Cone Penetration Tests (CPT)				
CPT-49+00E	153	36.97658	121.51224	Crest
CPT-50+00W	154	36.97634	121.51352	Crest
CPT-55+00E	154	36.97726	121.51478	Crest
CPT-61+50W	158	36.97711	121.51669	Crest
CPT-69+00W	160	36.97863	121.51919	Crest
CPT-74+50E	162	36.98040	121.51965	Crest
CPT-78+00W	163	36.98090	121.52123	Crest
CPT-83+00E	162	36.98259	121.52155	Crest
CPT-88+00W	164	36.98296	121.52313	Crest
CPT-92+50E	164	36.98473	121.52343	Crest
CPT-98+50W	164	36.98517	121.52524	Crest
CPT-99+50E	164	36.98588	121.52478	Crest
CPT-107+00W	166	36.98659	121.52743	Crest
CPT-108+50E	166	36.98739	121.52722	Crest
CPT-114+00W	168	36.98766	121.52931	Crest
CPT-119+50W	170	36.98850	121.53096	Crest
CPT-126+00E	173	36.99029	121.53122	Crest
CPT-132+00W	171	36.99161	121.53287	Crest
CPT-138+50E	174	36.99370	121.53298	Crest
CPT-141+00W	173	36.99390	121.53080	Crest
CPT-147+50W	174	36.99587	121.53468	Crest
CPT-148+00E	174	36.99603	121.53382	Crest
CPT-156+50E	178	36.99771	121.53389	Crest
CPT-157+00W	178	36.99789	121.53491	Crest
CPT-161+00E	181	36.99945	121.53445	Crest
CPT-166+75W	183	37.00062	121.53619	Crest
CPT-173+50W	185	37.00217	121.53706	Crest
CPT-175+00E	186	37.00289	121.53639	Crest
Soil Borings				
B-50+00W	154	36.97630	121.51342	Crest
B-59+00W	155	36.97695	121.51626	Crest
B-65+00E	158	36.97858	121.51797	Crest
B-78+00W	164	36.98085	121.52123	Crest
B-92+50E	150	36.98475	121.52328	Landside Toe
B-92+50W	164	36.98396	121.52404	Crest
B-107+00W	166	36.98655	121.52741	Crest
B-116+50E	169	36.98863	121.52930	Crest
B-127+00W	171	36.98998	121.53213	Crest
B-132+00W	172	36.99153	121.53283	Crest
B-132+50E	175	36.99226	121.53213	Crest
B-141+00W	173	36.99387	121.53411	Crest
B-148+00E	175	36.99606	121.53381	Crest
B-166+50E	182	37.00078	121.53518	Crest
B-173+50W	185	37.00214	121.53708	Crest
Stand-Pipe Piezometers				
P-132+50E	175	36.99220	121.53211	Crest
P-173+50W	185	37.00223	121.53706	Crest

Investigation ID indicates approximate station and side of creek where explorations was performed (Ex. CPT-49+00E was performed at approximate Station 49+00 on the east bank of Llagas Creek).

TABLE 2

Lower Llagas Capacity Restoration Project
Existing Conditions
Freeboard Table

Legend

🔴 Levees overtopped
🟡 Design flow contained, but inadequate freeboard
🟢 Adequate freeboard per FEMA policy

Station (feet)	(East Levee) Left Levee El. (looking d/s) (ft)	(West Levee) Right Levee El. (looking d/s) (ft)	Q Total (cfs)	Min Ch El. (ft)	W.S. El. (ft)	Freeboard	
						(East Levee) L (ft)	(West Levee) R (ft)
100	148.08	148.56	9,500	136.31	145.6	🟡 2.48	🟡 2.96
200	147.84	148.71	9,500	136.17	146.43	🟡 1.41	🟡 2.28
300	148.12	149.1	9,500	136.08	146.98	🟡 1.14	🟡 2.12
400	148.67	148.9	9,500	136.25	147.42	🟡 1.25	🟡 1.48
500	148.67	148.58	9,500	136.37	147.82	🟡 0.85	🟡 0.76
600	148.62	148.59	9,500	136.33	148.22	🟡 0.40	🟡 0.37
700	149.02	148.42	9,500	136.42	148.55	🟡 0.47	🔴 (0.13)
800	149.18	148.43	9,500	136.43	148.63	🟡 0.55	🔴 (0.20)
900	149	148.58	9,500	136.24	148.72	🟡 0.28	🔴 (0.14)
1000	148.99	148.92	9,500	136.19	148.74	🟡 0.25	🟡 0.18
1100	149.16	148.7	9,500	136.41	149.04	🟡 0.12	🔴 (0.34)
1200	148.92	149.08	9,500	135.95	149.14	🔴 (0.22)	🔴 (0.06)
1300	149.36	149.1	9,500	136.43	149.15	🟡 0.21	🔴 (0.05)
1400	149.3	149.35	9,500	136.48	149.18	🟡 0.12	🟡 0.17
1500	149.8	149.4	9,500	136.41	149.46	🟡 0.34	🔴 (0.06)
1600	149.56	148.92	9,500	136.4	149.56	🟡 0.00	🔴 (0.64)
1700	150.01	149.11	9,500	136.34	149.57	🟡 0.44	🔴 (0.46)
1800	150.48	149.58	9,500	136.39	149.64	🟡 0.84	🔴 (0.06)
1900	150.45	149.67	9,500	136.56	149.72	🟡 0.73	🔴 (0.05)
2000	150.3	149.9	9,500	136.58	149.75	🟡 0.55	🟡 0.15
2100	150.33	150.55	9,500	136.52	150.01	🟡 0.32	🟡 0.54
2200	150.54	150.16	9,500	136.63	150.27	🟡 0.27	🔴 (0.11)
2300	150.42	150.33	9,500	136.74	150.27	🟡 0.15	🟡 0.06
2400	150.82	149.59	9,500	136.61	150.51	🟡 0.31	🔴 (0.92)
2500	150.91	149.77	9,500	136.49	150.54	🟡 0.37	🔴 (0.77)
2600	150.68	150.69	9,500	136.74	150.5	🟡 0.18	🟡 0.19
2700	151.06	151.03	9,500	136.48	150.73	🟡 0.33	🟡 0.30
2800	151.29	151.55	13,200	136.76	150.89	🟡 0.40	🟡 0.66
2900	151.88	151.43	13,200	136.87	151.29	🟡 0.59	🟡 0.14
3000	151.86	151.75	13,200	136.98	151.65	🟡 0.21	🟡 0.10
3100	152.16	151.96	13,200	136.66	152.02	🟡 0.14	🔴 (0.06)
3200	152.33	152.31	13,200	136.59	151.95	🟡 0.38	🟡 0.36
3300	152.05	152.05	13,200	136.84	152.34	🔴 (0.29)	🔴 (0.29)
3400	151.93	152.17	13,200	137	152.35	🔴 (0.42)	🔴 (0.18)
3500	151.73	152.07	13,200	137	152.37	🔴 (0.64)	🔴 (0.30)
3600	152.05	152.16	13,200	136.93	152.39	🔴 (0.34)	🔴 (0.23)
3700	152.14	151.96	13,200	137.18	152.4	🔴 (0.26)	🔴 (0.44)
3800	152.1	151.85	13,200	137.02	152.42	🔴 (0.32)	🔴 (0.57)
3900	151.93	152.05	13,200	136.96	152.44	🔴 (0.51)	🔴 (0.39)
4000	151.98	152.31	13,200	137.5	152.45	🔴 (0.47)	🔴 (0.14)
4100	152.47	152.61	13,200	137.25	152.27	🟡 0.20	🟡 0.34
4200	152.88	153.2	13,200	137.51	152.62	🟡 0.26	🟡 0.58
4300	153.11	153.37	13,200	137.25	152.97	🟡 0.14	🟡 0.40

(Provided by SCVWD for Project Use)

TABLE 2

Lower Llagas Creek Capacity Restoration Project

	(East Levee)	(West Levee)				(East Levee)	(West Levee)	
Station (feet)	Left Levee El. (looking d/s) (ft)	Right Levee El. (looking d/s) (ft)	Q Total (cfs)	Min Ch El. (ft)	W.S. El. (ft)	Freeboard		
						L (ft)	R (ft)	
4400	152.76	153.61	13,200	137.34	153.33	🔴 (0.57)	🟡 0.28	
4500	153.91	153.6	13,200	137.96	153.22	🟡 0.69	🟡 0.38	
4591.631	152.99	153.53	16,000	137.96	153.59	🔴 (0.60)	🔴 (0.06)	
4611.64	152.8	153.44	16,000	138.03	153.6	🔴 (0.80)	🔴 (0.16)	
4663	157	157	16,000	138.03	153.28	🟡 3.72	🟡 3.72	Begin Project
4684.5	0	0	Bridge	0	0	0.00	0.00	(Bloomfield Ave)
4705	157	157	16,000	138.08	153.72	🟡 3.28	🟡 3.28	
4761.43	152.84	154.84	16,000	138.08	154.25	🔴 (1.41)	🟡 0.59	
4784.396	153.33	154.71	16,000	137.86	154.27	🔴 (0.94)	🟡 0.44	
4900	154.29	154.52	16,000	138.33	153.99	🟡 0.30	🟡 0.53	
5000	154.08	154.5	16,000	137.63	154.76	🔴 (0.68)	🔴 (0.26)	
5100	154.38	154.8	16,000	138.33	154.71	🔴 (0.33)	🟡 0.09	
5200	154.5	154.82	16,000	138.47	154.85	🔴 (0.35)	🔴 (0.03)	
5300	154.42	155.08	16,000	138.42	154.8	🔴 (0.38)	🟡 0.28	REACH 1
5400	154.67	155.33	16,000	138.84	154.84	🔴 (0.17)	🟡 0.49	
5500	154.92	155.12	16,000	138.97	154.56	🟡 0.36	🟡 0.56	
5600	154.71	154.89	16,000	139.67	155.34	🔴 (0.63)	🔴 (0.45)	
5700	155.25	154.85	16,000	140	155.36	🔴 (0.11)	🔴 (0.51)	
5800	155.52	155.1	16,000	140.12	155.31	🟡 0.21	🔴 (0.21)	
5900	156.35	155.48	16,000	140.05	155.02	🟡 1.33	🟡 0.46	
6000	157.09	156.15	16,000	140.05	155.62	🟡 1.47	🟡 0.53	
6100	157.88	158.54	16,000	140.08	156.2	🟡 1.68	🟡 2.34	
6200	157.81	160.39	16,000	140.22	156.63	🟡 1.18	🟢 3.76	
6300	158.01	160.67	18,800	140.17	156.86	🟡 1.15	🟢 3.81	
6400	158.71	160.73	18,800	140.34	157.2	🟡 1.51	🟢 3.53	
6500	158.76	160.6	18,800	140.33	157.52	🟡 1.24	🟡 3.08	
6600	159.16	160.64	18,800	140.09	157.92	🟡 1.24	🟡 2.72	
6700	160.23	160.75	18,800	140.59	158.22	🟡 2.01	🟡 2.53	
6800	161.32	160.58	18,800	140.48	158.53	🟡 2.79	🟡 2.05	
6900	161.37	160.87	18,800	140.58	158.76	🟡 2.61	🟡 2.11	
7000	161.2	163.15	18,800	140.52	158.99	🟡 2.21	🟢 4.16	
7100	161.21	163.18	18,800	140.53	159.19	🟡 2.02	🟢 3.99	
7200	161.45	162.42	18,800	140.36	159.37	🟡 2.08	🟡 3.05	
7300	161.5	161.74	18,800	140.5	159.57	🟡 1.93	🟡 2.17	
7400	161.92	163.86	18,800	140.22	159.77	🟡 2.15	🟢 4.09	
7500	162.31	164.31	18,800	140.54	159.93	🟡 2.38	🟢 4.38	
7600	162.4	164.27	18,800	140.64	160.1	🟡 2.30	🟢 4.17	
7700	162.63	164.17	18,800	140.69	160.28	🟡 2.35	🟢 3.89	REACH 2A
7800	162.83	163.98	18,800	140.82	160.44	🟡 2.39	🟢 3.54	
7900	162.94	164.2	18,800	140.68	160.6	🟡 2.34	🟢 3.60	
8000	162.94	164.29	18,800	140.75	160.75	🟡 2.19	🟢 3.54	
8100	162.56	164.1	18,800	141.2	160.9	🟡 1.66	🟡 3.20	
8200	162.64	164.64	18,800	140.86	161.06	🟡 1.58	🟢 3.58	
8300	163.08	164.35	18,800	141.16	161.22	🟡 1.86	🟡 3.13	
8400	162.66	164.56	18,800	141.51	161.37	🟡 1.29	🟡 3.19	
8500	163.21	164.39	18,800	141.81	161.52	🟡 1.69	🟡 2.87	
8600	163.35	163.74	18,800	141.98	161.71	🟡 1.64	🟡 2.03	
8700	163.37	164.2	18,800	141.98	161.76	🟡 1.61	🟡 2.44	
8800	164.44	164.25	18,800	141.97	161.8	🟡 2.64	🟡 2.45	
8900	164.2	164.32	18,800	142.69	162.32	🟡 1.88	🟡 2.00	
9000	163.9	164.37	18,800	142.22	162.64	🟡 1.26	🟡 1.73	

(Provided by SCVWD for Project Use)

TABLE 2

Lower Llagas Creek Capacity Restoration Project

	(East Levee)	(West Levee)				(East Levee)	(West Levee)	
Station (feet)	**Left Levee El. (looking d/s) (ft)**	**Right Levee El. (looking d/s) (ft)**	**Q Total (cfs)**	**Min Ch El. (ft)**	**W.S. El. (ft)**	**Freeboard**		
						L (ft)	**R (ft)**	
9100	164.46	164.27	18,800	142.39	162.78	🟡 1.68	🟡 1.49	
9200	164	164.09	18,800	142.92	162.93	🟡 1.07	🟡 1.16	
9300	164.72	164.59	18,800	142.91	163.08	🟡 1.64	🟡 1.51	
9400	164.49	165	18,800	142.97	163.25	🟡 1.24	🟡 1.75	
9500	164.42	165.24	18,800	142.7	163.43	🟡 0.99	🟡 1.81	
9600	164.9	165.21	18,800	143.17	163.58	🟡 1.32	🟡 1.63	
9700	164.72	164.96	18,800	144.17	163.74	🟡 0.98	🟡 1.22	
9800	165.08	164.71	18,800	144.06	163.91	🟡 1.17	🟡 0.80	
9900	165.17	165.08	18,800	143.69	164.1	🟡 1.07	🟡 0.98	
10000	165	165.28	18,800	144.02	164.25	🟡 0.75	🟡 1.03	
10100	165.28	165.4	18,800	143.65	164.42	🟡 0.86	🟡 0.98	
10200	165.3	165.17	18,800	143.51	164.59	🟡 0.71	🟡 0.58	
10300	165.63	165.32	18,800	144.71	164.75	🟡 0.88	🟡 0.57	
10400	165.87	165.6	18,800	144.17	164.91	🟡 0.96	🟡 0.69	
10500	166.06	165.48	18,800	144.66	165.08	🟡 0.98	🟡 0.40	
10600	166	165.87	18,800	144.84	165.25	🟡 0.75	🟡 0.62	
10700	166.06	166.1	18,800	145.33	165.42	🟡 0.64	🟡 0.68	
10800	166	166.71	18,800	145.76	165.61	🟡 0.39	🟡 1.10	
10900	167.02	166.98	18,800	145.72	165.66	🟡 1.36	🟡 1.32	REACH 2A
11000	168.32	167.68	18,800	146.99	165.74	🟡 2.58	🟡 1.94	
11100	168.89	169.71	18,800	148.33	166.39	🟡 2.50	🟡 3.32	
11200	169.13	170.85	18,800	148.65	167	🟡 2.13	🟢 3.85	
11300	169.57	168.33	18,800	148.59	167.23	🟡 2.34	🟡 1.10	
11400	168.73	168.82	18,800	148.25	167.44	🟡 1.29	🟡 1.38	
11500	168.92	169.28	18,800	148.89	167.63	🟡 1.29	🟡 1.65	
11600	168.68	169.18	18,800	148.56	167.82	🟡 0.86	🟡 1.36	
11700	169.55	198.12	18,800	148.46	168.01	🟡 1.54	🟢 30.11	
11800	170.1	212.58	18,800	148.16	168.22	🟡 1.88	🟢 44.36	
11900	170.21	226.38	18,800	148.33	168.41	🟡 1.80	🟢 57.97	
12000	169.68	218.13	18,800	148.5	168.59	🟡 1.09	🟢 49.54	
12100	170.03	181.98	18,800	148.4	168.75	🟡 1.28	🟢 13.23	
12200	170.2	170.03	18,800	148.93	168.92	🟡 1.28	🟡 1.11	
12300	169.85	169.95	18,800	149	169.05	🟡 0.80	🟡 0.90	
12400	170.25	170.04	18,500	148.85	169.25	🟡 1.00	🟡 0.79	
12500	170.35	170.83	18,500	149.08	169.4	🟡 0.95	🟡 1.43	
12600	173.17	171.55	18,500	148.94	169.54	🟡 3.63	🟡 2.01	
12670	174.3	171.5	18,500	149.17	169.66	🟢 4.64	🟡 1.84	
12691	174.3	171.5	18,500	149.17	169.7	🟢 4.60	🟡 1.80	
12704.5	0	0	Bridge	0	0	0.00	0.00	(Southside Dr)
12718	174.3	171.5	18,500	149.17	169.92	🟢 4.38	🟡 1.58	
12730	174.3	171.5	18,500	149.17	169.95	🟢 4.35	🟡 1.55	
12800	175	171.57	18,500	150.21	170.07	🟢 4.93	🟡 1.50	
12900	174.75	167.55	18,500	150.5	170.3	🟢 4.45	🔴 (2.75)	
13000	174.58	169.48	18,500	150.16	170.4	🟢 4.18	🔴 (0.92)	REACH 2B
13100	174.72	170.21	18,500	150.25	170.51	🟢 4.21	🔴 (0.30)	(SOUTH)
13200	174.87	173.18	18,500	150.5	170.49	🟢 4.38	🟡 2.69	
13300	175	173.56	18,500	150.06	170.66	🟢 4.34	🟡 2.90	
13400	174.83	173.71	18,500	150.57	170.78	🟢 4.05	🟡 2.93	
13500	174.99	173.31	18,500	150.55	170.92	🟢 4.07	🟡 2.39	
13600	175.08	173.73	18,500	150.33	171.09	🟢 3.99	🟡 2.64	
13700	174.79	173.52	18,500	150.62	171.23	🟢 3.56	🟡 2.29	

(Provided by SCVWD for Project Use)

TABLE 2

Lower Llagas Creek Capacity Restoration Project

	(East Levee)	(West Levee)				(East Levee)	(West Levee)
						Freeboard	
Station (feet)	Left Levee El. (looking d/s) (ft)	Right Levee El. (looking d/s) (ft)	Q Total (cfs)	Min Ch El. (ft)	W.S. El. (ft)	L (ft)	R (ft)
13800	174.93	173.53	18,500	150.48	171.33	🟢 3.60	🟡 2.20
13900	175.78	173.53	18,500	150.33	171.42	🟢 4.36	🟡 2.11
14000	174.85	174.43	18,500	150.33	171.52	🟡 3.33	🟡 2.91
14100	174.34	173.72	18,500	150.46	171.66	🟡 2.68	🟡 2.06
14200	174.08	174	18,500	150.14	171.77	🟡 2.31	🟡 2.23
14300	174.08	174.74	18,500	150.94	171.92	🟡 2.16	🟡 2.82
14400	174.37	174.19	18,500	150.5	172.03	🟡 2.34	🟡 2.16
14500	174.33	174.25	18,500	150.54	172.13	🟡 2.20	🟡 2.12
14600	175.3	174.23	18,500	150.78	172.26	🟡 3.04	🟡 1.97
14700	174.25	174.27	18,500	152.38	172.32	🟡 1.93	🟡 1.95
14800	174.8	174.82	18,500	152.1	172.3	🟡 2.50	🟡 2.52
14900	174.88	175.37	18,500	152.42	172.04	🟡 2.84	🟡 3.33
15000	179.39	179.09	18,500	155.09	172.09	🟢 7.30	🟢 7.00
15100	178.72	178.5	18,500	155.14	173.74	🟢 4.98	🟢 4.76
15200	178.58	178.62	18,500	155.09	174	🟢 4.58	🟢 4.62
15300	178.96	178.55	18,500	155.16	174.14	🟢 4.82	🟢 4.41
15400	178.51	178.69	18,500	155.43	174.29	🟢 4.22	🟢 4.40
15500	178.91	178.76	18,500	155.58	174.42	🟢 4.49	🟢 4.34
15600	178.75	178.87	18,500	155	174.56	🟢 4.19	🟢 4.31
15700	179.29	178.93	18,500	155.63	174.7	🟢 4.59	🟢 4.23
15800	179.16	178.62	18,500	155.59	174.84	🟢 4.32	🟢 3.78
15900	179.09	178.63	18,500	155.31	174.97	🟢 4.12	🟢 3.66
16000	179.51	178.6	18,500	155.23	175.13	🟢 4.38	🟢 3.47
16100	179.84	178.51	18,500	155.37	175.21	🟢 4.63	🟢 3.30
16200	179.81	178.71	18,500	155.51	175.01	🟢 4.80	🟢 3.70
16300	181.21	182.67	18,500	158.46	174.01	🟢 7.20	🟢 8.66
16400	181.66	180.38	18,500	159.35	177.23	🟢 4.43	🟢 3.15
16500	181.4	181.06	18,500	159.46	177.59	🟢 3.81	🟢 3.47
16600	181.61	181.02	18,500	159.48	177.72	🟢 3.89	🟢 3.30
16700	182.03	181.26	18,500	159.46	177.83	🟢 4.20	🟢 3.43
16800	182.66	182.23	18,500	159.69	177.98	🟢 4.68	🟢 4.25
16900	182.38	181.74	18,500	159.72	178.08	🟢 4.30	🟢 3.66
17000	183.46	181.62	18,500	159.92	178.21	🟢 5.25	🟢 3.41
17100	183.25	181.6	18,500	159.88	178.33	🟢 4.92	🟢 3.27
17200	184.01	183.8	18,500	159.58	178.17	🟢 5.84	🟢 5.63
17300	184.78	184.76	18,500	159.78	176.95	🟢 7.83	🟢 7.81
17400	184.26	185.66	18,500	163.95	179.21	🟢 5.05	🟢 6.45
17508.72	185.92	183.28	18,500	164.55	180.92	🟢 5.00	🟢 2.36
17530.57	185.74	183.7	18,500	164.83	180.97	🟢 4.77	🟢 2.73
17592	187	186	18,500	164.83	181.06	🟢 5.94	🟢 4.94
17639.5	0	0	Bridge	0	0	0.00	0.00
17687	190	188.19	18,500	164.43	181.4	🟢 8.60	🟢 6.79
17709.85	184.7	183.93	18,500	164.43	181.43	🟢 3.27	🟢 2.50
17731.34	184.49	184.24	18,500	164.58	181.45	🟢 3.04	🟢 2.79
17820	186.17	187.31	18,500	165.09	181.51	🟢 4.66	🟢 5.80
17900	187.1	183.17	18,500	165.06	181.67	🟢 5.43	🟢 1.50
18000	189.51	184.16	18,500	165.01	181.86	🟢 7.65	🟢 2.30

REACH 2B
(SOUTH)

REACH 2B
(NORTH)

(Highway 152)

End Project

(Provided by SCVWD for Project Use)

Table 3 - Field Exploration Subsurface Data Summary
Santa Clara Valley Water District
Lower Llagas Creek Capacity Restoration Project

Sample or Test Location							Moisture & Density Relationships			Atterberg Limits			Particle Size Analysis			Consolidation				Triaxial Consolidated Undrained				Triaxial Unconsolidated Undrained	Organic Content	Hydraulic Conductivity	Unconfined Compressive Strength	Torvane	Pocket Pen	Blow Counts	
							ASTM D2216			ASTM D4318			ASTM D422			ASTM D2435				ASTM D4767				ASTM D2850	ASTM D2974	ASTM D5084	ASTM D2166				
Boring	Depth	Elevation	Groundwater Depth	Groundwater Elevation	Soil Type	Geologic Layer	Moisture Content	Dry Unit Weight	Unit Weight	Liquid Limit	Plastic Limit	Plasticity Index	Gravel	Sand	Silt and Clay	Maximum Past Pressure	Compression Index	Recompression Index	Coefficient of Consolidation	Total Cohesion	Total Friction Angle	Effective Cohesion	Effective Friction Angle	Undrained Shear Strength	Method C- 440° C	Vertical Hydraulic Conductivity	Unconfined Compressive Strength	Undrained Shear Strength	Unconfined Compressive Strength	Blows per foot	Sampler Type
B	D						ω	γ_d	γ	LL	PL	PI	G	S	M & C	P_p	C_c	C_r	C_v	c	Φ	c'	ϕ'	s_u		k_y	q_u	s_u	q_u	N	
	(ft)	(ft)	(ft)	(ft)			(%)	(pcf)	(pcf)	(%)	(%)	(%)	(%)	(%)	(%)	(psf)			(ft^2/day)	(psf)	(deg)	(psf)	(deg)	(psf)	(%)	(cm/sec)	(psi)	(psf)	(tsf)		
B-050+00W	3	151	24	130	Fat CLAY (CH)	Levee Fill																							4.5+	22	MC
B-050+00W	4	150	24	130	Fat CLAY (CH) Bulk Sample	Levee Fill	28.5	86.6	111.3	69.9	22.4	47.5														2.00E-07				18	SPT
B-050+00W	7	147	24	130	Fat CLAY (CH)	Levee Fill																							4.5+	24	MC
B-050+00W	10.5	143.5	24	130	Fat CLAY (CH)	Levee Fill																							2.30	18	MC
B-050+00W	13	141	24	130	Fat CLAY (CH)	Softer Fine Grained Alluvium	37.3	83.7	114.9	55.3	25.0	30.3												680							SH
B-050+00W	13.9	140.1	24	130	Fat CLAY (CH)	Softer Fine Grained Alluvium																							0.75		
B-050+00W	14	140	24	130	Fat CLAY (CH)	Softer Fine Grained Alluvium																						700			
B-050+00W	15	139	24	130	Fat CLAY (CH)	Softer Fine Grained Alluvium																							1.25	20	MC
B-050+00W	16	138	24	130	Fat CLAY (CH)	Softer Fine Grained Alluvium	56.6	66.3	103.8	63.6	31.1	32.5								250	15.6	0	32.6								SH
B-050+00W	17.9	136.1	24	130	Fat CLAY (CH)	Softer Fine Grained Alluvium																							1.00		
B-050+00W	18	136	24	130	Fat CLAY (CH)	Softer Fine Grained Alluvium																						840			
B-050+00W	19.5	134.5	24	130	Fat CLAY (CH)	Softer Fine Grained Alluvium																							1.00	8	MC
B-050+00W	20	134	24	130	Fat CLAY (CH)	Softer Fine Grained Alluvium	69.6	57.8	98.0	91.7	31.6	60.1				3100															SH
B-050+00W	20.1	133.9	24	130	Fat CLAY (CH)	Softer Fine Grained Alluvium																									
B-050+00W	21.5	132.5	24	130	Fat CLAY (CH)	Softer Fine Grained Alluvium	62.9	62.4	101.6															615							
B-050+00W	21.9	132.1	24	130	Fat CLAY (CH)	Softer Fine Grained Alluvium																							0.30		
B-050+00W	22	132	24	130	Fat CLAY (CH)	Softer Fine Grained Alluvium																						560			
B-050+00W	23	131	24	130	PEAT (PT)	Peat	252.9	20.1	70.8																56.3				1.00	13	MC
B-050+00W	25	129	24	130	Elastic SILT (MH)	Softer Fine Grained Alluvium	92.5	46.2	88.9	86.0	44.5	41.5												675					1.25	14	MC
B-050+00W	30	124	24	130	Lean CLAY (CL)	Stiffer Fine Grained Alluvium																							0.75	13	MC
B-050+00W	35	119	24	130	Lean CLAY (CL)	Stiffer Fine Grained Alluvium																							1.25	21	MC
B-050+00W	39.5	114.5	24	130	Lean CLAY (CL)	Stiffer Fine Grained Alluvium																							1.40	25	MC
B-050+00W	49	105	24	130	Poorly Graded SAND (SP)	Clean Coarse Grained Alluvium	18.4						4.8	91.2	4.0															64	SPT
B-050+00W	60	94	24	130	Lean CLAY (CL) to Lean CLAY with Sand (CL)	Stiffer Fine Grained Alluvium																							1.00	28	SPT
B-059+00W	2	153	21	134	Fat CLAY (CH) to Fat CLAY with Gravel (CH)	Levee Fill																							4.5+	23	MC
B-059+00W	6	149	21	134	Fat CLAY (CH)	Levee Fill	25.9	91.7	115.5	71.2	25.8	45.4															32.2		4.50	31	MC
B-059+00W	11	144	21	134	Fat CLAY (CH)	Levee Fill	32.7	89.5	118.8															2331							SH
B-059+00W	11.9	143.1	21	134	Fat CLAY (CH)	Levee Fill																							2.90		
B-059+00W	13	142	21	134	Fat CLAY (CH)	Levee Fill																							4.25	40	MC
B-059+00W	15	140	21	134	Lean CLAY (CL)	Stiffer Fine Grained Alluvium	20.6	102.8	124.0							3100														20	SH
B-059+00W	15.5	139.5	21	134	Lean CLAY (CL)	Stiffer Fine Grained Alluvium	22.5	102.7	125.8	39.5	19.6	19.9												1510							
B-059+00W	15.9	139.1	21	134	Lean CLAY (CL)	Stiffer Fine Grained Alluvium																							0.60		
B-059+00W	16	139	21	134	Lean CLAY (CL)	Stiffer Fine Grained Alluvium																						800			
B-059+00W	17	138	21	134	Fat CLAY (CH)	Stiffer Fine Grained Alluvium																							1.40	20	MC
B-059+00W	20	135	21	134	PEAT (PT)	Peat	193.9	22.9	67.3															910	48.6					18	MC
B-059+00W	25	130	21	134	Fat CLAY (CH)	Stiffer Fine Grained Alluvium	43.5	78.7	113.0	53.9	24.7	29.2																	1.20	16	MC
B-059+00W	44	111	21	134	Poorly Graded SAND with Silt and Gravel (SP-SM)	Coarse Grained Alluvium with Fines	10.6						36.6	53.2	10.2															50/6"	SPT
B-059+00W	55	100	21	134	Lean CLAY (CL)	Stiffer Fine Grained Alluvium																							1.90	59	MC

Table 3 - Field Exploration Subsurface Data Summary
Santa Clara Valley Water District
Lower Llagas Creek Capacity Restoration Project

Sample or Test Location							Moisture & Density Relationships			Atterberg Limits			Particle Size Analysis			Consolidation				Triaxial Consolidated Undrained				Triaxial Unconsolidated Undrained	Organic Content	Hydraulic Conductivity	Unconfined Compressive Strength	Torvane	Pocket Pen	Blow Counts	
							ASTM D2216			ASTM D4318			ASTM D422			ASTM D2435				ASTM D4767				ASTM D2850	ASTM D2974	ASTM D5084	ASTM D2166				
Boring	Depth	Elevation	Groundwater Depth	Groundwater Elevation	Soil Type	Geologic Layer	Moisture Content	Dry Unit Weight	Unit Weight	Liquid Limit	Plastic Limit	Plasticity Index	Gravel	Sand	Silt and Clay	Maximum Past Pressure	Compression Index	Recompression Index	Coefficient of Consolidation	Total Cohesion	Total Friction Angle	Effective Cohesion	Effective Friction Angle	Undrained Shear Strength	Method C- 440° C	Vertical Hydraulic Conductivity	Unconfined Compressive Strength	Undrained Shear Strength	Unconfined Compressive Strength	Blows per foot	Sampler Type
B	D						ω	γ_d	γ	LL	PL	PI	G	S	M & C	P_p	C_c	C_r	C_v	c	Φ	c'	ϕ'	s_u		k_y	q_u	s_u	q_u	N	
	(ft)	(ft)	(ft)	(ft)			(%)	(pcf)	(pcf)	(%)	(%)	(%)	(%)	(%)	(%)	(psf)			(ft^2/day)	(psf)	(deg)	(psf)	(deg)	(psf)	(%)	(cm/sec)	(psi)	(psf)	(tsf)		
B-065+00E	2	156			Fat CLAY (CH)	Levee Fill	13.9	111.8	127.3																		95.3		4.5+	50	MC
B-065+00E	8.5	149.5			Fat CLAY with Gravel (CH)	Levee Fill	13.0	107.5	121.5	55.2	21.0	34.2																		17	MC
B-065+00E	9	149			Fat CLAY with Gravel (CH)	Levee Fill	25.1	92.9	116.2																		37.3				
B-065+00E	13	145			Lean to Fat CLAY (CL/CH)	Levee Fill	27.3	96.8	123.2																		25.9		3.80	27	MC
B-065+00E	16	142			Lean CLAY (CL)	Stiffer Fine Grained Alluvium	21.9	105.4	128.5	38.0	19.4	18.6												1885							SH
B-065+00E	17.9	140.1			Lean CLAY (CL)	Stiffer Fine Grained Alluvium																							2.30		
B-065+00E	21	137			Clayey PEAT (PT) to PEAT (PT)	Peat	71.7	54.9	94.3															835	34.1					21	MC
B-065+00E	26	132			Lean CLAY (CL)	Stiffer Fine Grained Alluvium																						1220	1.00	17	MC
B-065+00E	31	127			Lean CLAY (CL) to Lean CLAY with Sand (CL)	Stiffer Fine Grained Alluvium	25.3	100.3	125.7																				1.60	21	MC
B-065+00E	35.5	122.5			Lean CLAY (CL)	Stiffer Fine Grained Alluvium																							0.80	24	MC
B-065+00E	36.5	121.5			Lean CLAY (CL)	Stiffer Fine Grained Alluvium																							2.90		
B-065+00E	45.5	112.5			Well Graded GRAVEL with Sand (GW)	Clean Coarse Grained Alluvium	10.2	127.2	140.2				56.1	39.2	4.7															50/6"	MC
B-078+00W	3	161	28	136	Fat CLAY (CH) to Fat CLAY with Sand (CH)	Levee Fill																							3.20	21	MC
B-078+00W	7	157	28	136	Fat CLAY (CH)	Levee Fill	31.1	90.7	118.9	61.9	22.5	39.4															33.7		4.5+	21	MC
B-078+00W	11.5	152.5	28	136	Fat CLAY (CH)	Levee Fill																							4.25	22	MC
B-078+00W	17	147	28	136	Fat CLAY (CH)	Levee Fill	24.7	101.0	125.9	51.8	22.7	29.1															38.2		3.20	27	MC
B-078+00W	21.9	142.1	28	136	Lean CLAY (CL)	Stiffer Fine Grained Alluvium																						1000	1.80		SH
B-078+00W	25	139	28	136	Lean CLAY (CL)	Stiffer Fine Grained Alluvium	44.6	76.6	110.8	39.9	15.9	24.0								160	18.4	137	29.6								SH
B-078+00W	26.5	137.5	28	136	Lean CLAY (CL)	Stiffer Fine Grained Alluvium	25.5	98.5	123.6							5000															
B-078+00W	26.9	137.1	28	136	Lean CLAY (CL)	Stiffer Fine Grained Alluvium																							0.75		
B-078+00W	27	137	28	136	Lean CLAY (CL)	Stiffer Fine Grained Alluvium																						880			
B-078+00W	29	135	28	136	Silty SAND (SM)	Coarse Grained Alluvium with More Fines	24.1						1.0	76.0	23.0															19	SPT
B-078+00W	39	125	28	136	Well Graded SAND with Silt and Gravel (SW-SM)	Coarse Grained Alluvium with Fines	10.8						32.7	58.8	8.5															65	SPT
B-078+00W	50	114	28	136	SILT (ML)	Stiffer Fine Grained Alluvium	25.0	102.4	128.0																				1.00	13	MC
B-078+00W	55	109	28	136	Lean CLAY (CL)	Stiffer Fine Grained Alluvium																							1.25	21	MC
B-078+00W	60	104	28	136	Lean CLAY (CL)	Stiffer Fine Grained Alluvium																							1.25	37	MC
B-092+50E	3	147			Fat CLAY (CH)	Softer Fine Grained Alluvium	105.3	38.9	79.8	93.3	32.7	60.6																			SH
B-092+50E	4	146			Fat CLAY (CH)	Softer Fine Grained Alluvium	83.2	48.1	88.1											435	15.7	280	30.6								
B-092+50E	4.5	145.5			Fat CLAY (CH)	Softer Fine Grained Alluvium	63.1	60.5	98.7							3500															
B-092+50E	4.9	145.1			Fat CLAY (CH)	Softer Fine Grained Alluvium																							0.50		
B-092+50E	6	144			Fat CLAY (CH)	Softer Fine Grained Alluvium	54.2	68.2	105.2	84.6	26.3	58.3															5.9			11	MC
B-092+50E	8	142			Fat CLAY (CH)	Softer Fine Grained Alluvium	15.0	116.6	134.0																						SH
B-092+50E	9	141			Silty SAND with Gravel (SM)	Coarse Grained Alluvium with More Fines							14.8	63.0	22.2																
B-092+50E	15.3	134.7			SILT (ML)	Softer Fine Grained Alluvium	29.2			32.2	17.9	14.3																		7	MC
B-092+50E	41	109			Lean CLAY (CL) to Lean CLAY with Sand (CL)	Stiffer Fine Grained Alluvium	22.5	107.1	131.2																				2.75	49	MC
B-092+50E	45.5	104.5			Lean CLAY (CL)	Stiffer Fine Grained Alluvium																							1.75	19	MC

Table 3 - Field Exploration Subsurface Data Summary
Santa Clara Valley Water District
Lower Llagas Creek Capacity Restoration Project

Sample or Test Location							Moisture & Density Relationships			Atterberg Limits			Particle Size Analysis			Consolidation				Triaxial Consolidated Undrained				Triaxial Unconsolidated Undrained	Organic Content	Hydraulic Conductivity	Unconfined Compressive Strength	Torvane	Pocket Pen	Blow Counts	
							ASTM D2216			ASTM D4318			ASTM D422			ASTM D2435				ASTM D4767				ASTM D2850	ASTM D2974	ASTM D5084	ASTM D2166				
Boring	Depth	Elevation	Groundwater Depth	Groundwater Elevation	Soil Type	Geologic Layer	Moisture Content	Dry Unit Weight	Unit Weight	Liquid Limit	Plastic Limit	Plasticity Index	Gravel	Sand	Silt and Clay	Maximum Past Pressure	Compression Index	Recompression Index	Coefficient of Consolidation	Total Cohesion	Total Friction Angle	Effective Cohesion	Effective Friction Angle	Undrained Shear Strength	Method C- 440° C	Vertical Hydraulic Conductivity	Unconfined Compressive Strength	Undrained Shear Strength	Unconfined Compressive Strength	Blows per foot	Sampler Type
B	D						ω	γ_d	γ	LL	PL	PI	G	S	M & C	P_p	C_c	C_r	C_v	c	Φ	c'	ϕ'	s_u		k_y	q_u	s_u	q_u	N	
	(ft)	(ft)	(ft)	(ft)			(%)	(pcf)	(pcf)	(%)	(%)	(%)	(%)	(%)	(%)	(psf)			(ft^2/day)	(psf)	(deg)	(psf)	(deg)	(psf)	(%)	(cm/sec)	(psi)	(psf)	(tsf)		
B-092+50W	3	161	26	138	Fat CLAY (CH)	Levee Fill	26.4	95.3	120.5																		26.4		2.50	21	MC
B-092+50W	7	157	26	138	Fat CLAY (CH)	Levee Fill	28.4	90.9	116.7	62.2	24.4	37.8															36.7		4.5+	30	MC
B-092+50W	11.5	152.5	26	138	Fat CLAY (CH)	Levee Fill																							4.10	29	MC
B-092+50W	17	147	26	138	Lean CLAY (CL)	Stiffer Fine Grained Alluvium																							1.50	16	MC
B-092+50W	20.9	143.1	26	138	Lean CLAY (CL) to Lean CLAY with Gravel (CL)	Stiffer Fine Grained Alluvium																							1.70		SH
B-092+50W	21.5	142.5	26	138	SILT (ML)	Softer Fine Grained Alluvium																							1.00	13	MC
B-092+50W	22	142	26	138	Lean CLAY (CL)	Softer Fine Grained Alluvium	28.5	95.1	122.2																		9.3		1.30		
B-092+50W	25	139	26	138	Silty SAND (SM)	Coarse Grained Alluvium with More Fines	16.7	116.1	135.5	18.2	13.9	4.3	8.9	46.6	44.5									330							SH
B-092+50W	25.9	138.1	26	138	Silty SAND (SM)	Coarse Grained Alluvium with More Fines																							0.10		
B-092+50W	30	134	26	138	Well Graded SAND with Silt and Gravel (SW-SM)	Coarse Grained Alluvium with Fines	12.1	121.2	135.9				45.5	46.5	8.0															44	MC
B-092+50W	45	119	26	138	Lean CLAY (CL)	Stiffer Fine Grained Alluvium																							2.25	29	MC
B-092+50W	50	114	26	138	SILT (ML)	Stiffer Fine Grained Alluvium																							1.30	33	MC
B-092+50W	55	109	26	138	SILT (ML)	Stiffer Fine Grained Alluvium																							1.70	19	MC
B-092+50W	60	104	26	138	Lean CLAY (CL)	Stiffer Fine Grained Alluvium																							2.90	32	MC
B-107+00W	6	160	20	146	Fat CLAY with Sand (CH)	Levee Fill	24.9	93.6	116.9	64.7	29.1	35.6															57.1		4.5+	47	MC
B-107+00W	10	156	20	146	Fat CLAY (CH)	Stiffer Fine Grained Alluvium																							4.50	27	MC
B-107+00W	12	154	20	146	Fat CLAY (CH)	Stiffer Fine Grained Alluvium	33.9	86.3	115.6	62.7	19.4	43.3				7500															SH
B-107+00W	13.5	152.5	20	146	Fat CLAY (CH)	Stiffer Fine Grained Alluvium	36.6	84.6	115.6															1624							
B-107+00W	14	152	20	146	Fat CLAY (CH)	Stiffer Fine Grained Alluvium																						1400	1.25		
B-107+00W	16	150	20	146	Lean CLAY (CL)	Stiffer Fine Grained Alluvium																						1800	2.00	17	MC
B-107+00W	20	146	20	146	Silty SAND (SM)	Coarse Grained Alluvium with More Fines	21.6	108.7	132.2				6.0	60.7	33.3															23	MC
B-107+00W	24	142	20	146	Well Graded SAND with Clay and Gravel (SW-SC)	Coarse Grained Alluvium with Fines	11.2						34.1	56.7	9.2															66	SPT
B-107+00W	30	136	20	146	Lean CLAY (CL)	Stiffer Fine Grained Alluvium	21.7	107.1	130.3																				4.20	35	MC
B-107+00W	45	121	20	146	Lean CLAY (CL)	Stiffer Fine Grained Alluvium																							4.00	34	MC
B-107+00W	50	116	20	146	SILT with Sand (ML)	Stiffer Fine Grained Alluvium																							1.50	21	MC
B-107+00W	60	106	20	146	Lean CLAY (CL)	Stiffer Fine Grained Alluvium																							2.25	51	MC
B-116+50E	3	166			Fat CLAY (CH) to Fat CLAY with Sand (CH)	Levee Fill																							4.5+	42	MC
B-116+50E	7	162			Sandy SILT with Gravel (ML)	Levee Fill																							4.5+	23	MC
B-116+50E	10	159			Fat CLAY (CH)	Stiffer Fine Grained Alluvium				65.5	23.3	42.2																			SH
B-116+50E	11	158			Fat CLAY (CH)	Stiffer Fine Grained Alluvium	30.8	91.2	119.3															2177							
B-116+50E	11.9	157.1			Fat CLAY (CH)	Stiffer Fine Grained Alluvium																							2.90		
B-116+50E	12	157			Fat CLAY (CH)	Stiffer Fine Grained Alluvium																						1060			
B-116+50E	13	156			Lean CLAY (CL)	Stiffer Fine Grained Alluvium																							2.75	21	MC
B-116+50E	16	153			Lean CLAY (CL)	Stiffer Fine Grained Alluvium	17.9	111.8	131.8																				3.00	28	MC
B-116+50E	20	149			Lean CLAY (CL)	Stiffer Fine Grained Alluvium	19.4	109.7	131.0	34.9	16.4	18.5															25.6		4.20	34	MC
B-116+50E	25	144			Sandy SILT with Gravel (ML)	Stiffer Fine Grained Alluvium																							2.70	55	MC
B-116+50E	29	140			Lean CLAY (CL)	Stiffer Fine Grained Alluvium																							1.90	25	MC
B-116+50E	30	139			Lean CLAY (CL)	Stiffer Fine Grained Alluvium	24.7	101.1	126.1																				2.00		
B-116+50E	35	134			Lean CLAY (CL)	Stiffer Fine Grained Alluvium																							1.25	18	MC
B-116+50E	40	129			Lean CLAY (CL)	Stiffer Fine Grained Alluvium																							2.10	27	MC
B-116+50E	50	119			SILT (ML) to SILT with Sand (ML)	Stiffer Fine Grained Alluvium																							1.50	27	MC
B-116+50E	65	104			SILT (ML)	Stiffer Fine Grained Alluvium																							1.70	52	MC

Table 3 - Field Exploration Subsurface Data Summary
Santa Clara Valley Water District
Lower Llagas Creek Capacity Restoration Project

Sample or Test Location							Moisture & Density Relationships			Atterberg Limits			Particle Size Analysis			Consolidation				Triaxial Consolidated Undrained				Triaxial Unconsolidated Undrained	Organic Content	Hydraulic Conductivity	Unconfined Compressive Strength	Torvane	Pocket Pen	Blow Counts	
							ASTM D2216			ASTM D4318			ASTM D422			ASTM D2435				ASTM D4767				ASTM D2850	ASTM D2974	ASTM D5084	ASTM D2166				
Boring	Depth	Elevation	Groundwater Depth	Groundwater Elevation	Soil Type	Geologic Layer	Moisture Content	Dry Unit Weight	Unit Weight	Liquid Limit	Plastic Limit	Plasticity Index	Gravel	Sand	Silt and Clay	Maximum Past Pressure	Compression Index	Recompression Index	Coefficient of Consolidation	Total Cohesion	Total Friction Angle	Effective Cohesion	Effective Friction Angle	Undrained Shear Strength	Method C- 440° C	Vertical Hydraulic Conductivity	Unconfined Compressive Strength	Undrained Shear Strength	Unconfined Compressive Strength	Blows per foot	Sampler Type
B	D						ω	γ_d	γ	LL	PL	PI	G	S	M & C	P_p	C_c	C_r	C_v	c	Φ	c'	ϕ'	s_u		k_y	q_u	s_u	q_u	N	
	(ft)	(ft)	(ft)	(ft)			(%)	(pcf)	(pcf)	(%)	(%)	(%)	(%)	(%)	(%)	(psf)			(ft^2/day)	(psf)	(deg)	(psf)	(deg)	(psf)	(%)	(cm/sec)	(psi)	(psf)	(tsf)		
B-127+00W	2	169			Lean CLAY (CL) to Lean CLAY with Gravel (CL)	Levee Fill																							4.5+	41	MC
B-127+00W	6	165			Lean CLAY (CL) to Lean CLAY with Sand (CL)	Levee Fill	14.3	101.9	116.5	40.5	18.1	22.4															36.4		4.5+	19	MC
B-127+00W	9	162			Lean CLAY (CL)	Stiffer Fine Grained Alluvium	28.3	91.4	117.3															2777							SH
B-127+00W	9.9	161.1			Lean CLAY (CL)	Stiffer Fine Grained Alluvium																							3.40		
B-127+00W	11.5	159.5			Lean to Fat CLAY (CL/CH)	Stiffer Fine Grained Alluvium																							2.30	18	MC
B-127+00W	14	157			Lean CLAY (CL)	Stiffer Fine Grained Alluvium				40.1	17.7	22.4																			SH
B-127+00W	15	156			Lean CLAY (CL)	Stiffer Fine Grained Alluvium	21.9	99.3	121.0															2100							
B-127+00W	15.9	155.1			Lean CLAY (CL) to Lean CLAY with Sand (CL)	Stiffer Fine Grained Alluvium																							1.75		
B-127+00W	16	155			Lean CLAY (CL) to Lean CLAY with Sand (CL)	Stiffer Fine Grained Alluvium																						1100			
B-127+00W	17	154			SILT with Sand (ML)	Stiffer Fine Grained Alluvium	25.6	101.7	127.7				1.7	25.9	72.4															11	MC
B-127+00W	20	151			Lean CLAY (CL)	Stiffer Fine Grained Alluvium	30.8	93.3	122.0																				0.90	15	MC
B-127+00W	25	146			Poorly Graded GRAVEL with Clay and Sand (GP-GC)	Coarse Grained Alluvium with Fines	11.0	133.4	148.1				36.0	51.1	12.9															43	MC
B-127+00W	29	142			Poorly Graded SAND with Silt (SP-SM)	Coarse Grained Alluvium with Fines	16.5						12.0	82.7	5.3															85	MC
B-127+00W	45	126			Elastic SILT (ML)	Stiffer Fine Grained Alluvium																							1.25	27	MC
B-132+00W	6	166			Fat CLAY (CH)	Softer Fine Grained Alluvium	37.0	72.5	99.3	71.2	28.3	42.9															18.1			22	MC
B-132+00W	6.5	165.5			Fat CLAY (CH)	Stiffer Fine Grained Alluvium																									
B-132+00W	11	161			Lean CLAY (CL)	Stiffer Fine Grained Alluvium	25.1	96.2	120.3																				4.5+	35	MC
B-132+00W	15.5	156.5			SILT with Sand (ML) to Sandy SILT (ML)	Stiffer Fine Grained Alluvium																							3.10	29	MC
B-132+00W	16	156			SILT with Sand (ML) to Sandy SILT (ML)	Stiffer Fine Grained Alluvium	17.9	98.9	116.6				0.3	45.3	54.4																
B-132+00W	25	147			Poorly Graded SAND with Silt and Gravel (SP-SM)	Coarse Grained Alluvium with Fines	13.8	113.6	129.3				19.2	73.8	7.0															53	MC
B-132+00W	34	138			Poorly Graded SAND with Gravel (SP)	Clean Coarse Grained Alluvium	17.1						14.9	83.3	1.8															50/6"	SPT
B-132+50E	3	172			Fat CLAY (CH) to Fat CLAY with Sand (CH)	Levee Fill	20.4	107.0	128.8																				4.5+	32	MC
B-132+50E	7	168			Fat CLAY (CH)	Levee Fill	25.5	99.5	124.9																		18.9		2.40	15	MC
B-132+50E	10	165			Lean CLAY (CL)	Stiffer Fine Grained Alluvium				49.3	18.5	30.8																			SH
B-132+50E	11	164			Lean CLAY (CL)	Stiffer Fine Grained Alluvium	24.2	101.0	125.4															3000							
B-132+50E	11.9	163.1			Lean CLAY (CL)	Stiffer Fine Grained Alluvium																							4.00		
B-132+50E	13	162			Lean CLAY (CL)	Stiffer Fine Grained Alluvium																							3.40	30	MC
B-132+50E	16	159			Sandy SILT (ML)	Stiffer Fine Grained Alluvium	23.3	101.8	125.5				0.0	36.7	63.3														1.30	15	MC
B-132+50E	20	155			Lean CLAY (CL)	Softer Fine Grained Alluvium	23.6	102.6	126.8																		4.7		0.90	10	MC
B-132+50E	25	150			Lean CLAY (CL) to Lean CLAY with Sand (CL)	Stiffer Fine Grained Alluvium																							4.5+	65	MC
B-132+50E	29.5	145.5			Poorly Graded SAND with Silt and Gravel (SP-SM)	Coarse Grained Alluvium with Fines	17.5						19.9	71.2	8.9															73	MC
B-132+50E	39	136			Well Graded SAND (SW)	Clean Coarse Grained Alluvium	14.8						10.3	86.1	3.6															24	SPT
B-132+50E	45	130			Lean CLAY (CL)	Stiffer Fine Grained Alluvium																							1.20	14	MC
B-141+00W	2	171			Sandy Lean CLAY (CL)	Levee Fill	10.5	112.4	124.2				3.7	42.7	53.6															30	MC
B-141+00W	3	170			Clayey SAND with Gravel (SC)	Levee Fill	5.8						24.8	54.9	20.3															18	SPT
B-141+00W	5.5	167.5			Poorly Graded GRAVEL with Sand (GP)	Levee Fill	5.9						6.9	75.3	17.8															16	MC
B-141+00W	10.5	162.5			Lean CLAY (CL)	Stiffer Fine Grained Alluvium	24.3	100.6	125.0	46.9	19.4	27.5																		28	MC
B-141+00W	11	162			Lean CLAY (CL)	Stiffer Fine Grained Alluvium	24.4	100.0	124.4																		32.3		3.30		
B-141+00W	16	157			Lean CLAY (CL) to Lean CLAY with Sand (CL)	Stiffer Fine Grained Alluvium																							1.50	11	MC
B-141+00W	19.9	153.1			Sandy Lean CLAY (CL)																								0.80		SH
B-141+00W	24	149			Poorly Graded SAND with Silt and Gravel (SP-SM)	Coarse Grained Alluvium with Fines	13.4						27.4	61.2	11.4															45	SPT
B-141+00W	29.5	143.5			Poorly Graded Gravel with Silt and Sand (GP-GM)	Coarse Grained Alluvium with Fines	10.4	132.7	146.5				51.3	41.6	7.1															50/6"	MC
B-141+00W	45	128			Lean CLAY (CL)	Stiffer Fine Grained Alluvium																							1.80	26	MC

Table 3 - Field Exploration Subsurface Data Summary
Santa Clara Valley Water District
Lower Llagas Creek Capacity Restoration Project

Sample or Test Location							Moisture & Density Relationships			Atterberg Limits			Particle Size Analysis			Consolidation				Triaxial Consolidated Undrained				Triaxial Unconsolidated Undrained	Organic Content	Hydraulic Conductivity	Unconfined Compressive Strength	Torvane	Pocket Pen	Blow Counts	
							ASTM D2216			ASTM D4318			ASTM D422			ASTM D2435				ASTM D4767				ASTM D2850	ASTM D2974	ASTM D5084	ASTM D2166				
Boring	Depth	Elevation	Groundwater Depth	Groundwater Elevation	Soil Type	Geologic Layer	Moisture Content	Dry Unit Weight	Unit Weight	Liquid Limit	Plastic Limit	Plasticity Index	Gravel	Sand	Silt and Clay	Maximum Past Pressure	Compression Index	Recompression Index	Coefficient of Consolidation	Total Cohesion	Total Friction Angle	Effective Cohesion	Effective Friction Angle	Undrained Shear Strength	Method C- 440° C	Vertical Hydraulic Conductivity	Unconfined Compressive Strength	Undrained Shear Strength	Unconfined Compressive Strength	Blows per foot	Sampler Type
B	D						ω	γ_d	γ	LL	PL	PI	G	S	M & C	P_p	C_c	C_r	C_v	c	Φ	c'	ϕ'	s_u		k_y	q_u	s_u	q_u	N	
	(ft)	(ft)	(ft)	(ft)			(%)	(pcf)	(pcf)	(%)	(%)	(%)	(%)	(%)	(%)	(psf)			(ft^2/day)	(psf)	(deg)	(psf)	(deg)	(psf)	(%)	(cm/sec)	(psi)	(psf)	(tsf)		
B-148+00E	0.5	174.5			Sandy SILT (ML)	Artificial Fill	14.3						0.9	38.7	60.4															26	SPT
B-148+00E	6	169			Fat CLAY (CH)	Stiffer Fine Grained Alluvium	33.0	85.7	114.0	61.7	27.8	33.9															28.9		3.00	24	MC
B-148+00E	11	164			Lean CLAY (CL)	Stiffer Fine Grained Alluvium	26.5	95.5	120.9																				2.60	32	MC
B-148+00E	18	157			Lean CLAY (CL)	Softer Fine Grained Alluvium				44.8	19.3	25.5																			SH
B-148+00E	19	156			Lean CLAY (CL)	Softer Fine Grained Alluvium	31.2	91.5	120.0															710							
B-148+00E	19.9	155.1			Lean CLAY (CL)	Softer Fine Grained Alluvium																							0.25		
B-148+00E	20	155			Lean CLAY (CL)	Softer Fine Grained Alluvium																						800			
B-148+00E	21.5	153.5			Lean CLAY (CL)	Stiffer Fine Grained Alluvium																							1.50	7	MC
B-148+00E	30	145			Poorly Graded Gravel with Silt and Sand (GP-GM)	Coarse Grained Alluvium with Fines	9.6						56.0	35.8	8.2															66	SPT
B-166+50E	2	180			SILT with Sand and Gravel (ML) to Sandy SILT (ML)	Artificial Fill	11.8	102.4	114.5				7.2	36.0	56.8															40	MC
B-166+50E	6	176			SILT (ML)	Stiffer Fine Grained Alluvium																							2.75	8	MC
B-166+50E	6.5	175.5			Silty SAND (SM)	Coarse Grained Alluvium with More Fines	13.9						0.1	58.0	41.9															10	SPT
B-166+50E	11.9	170.1			Lean CLAY (CL) to Lean CLAY with Sand (CL)	Stiffer Fine Grained Alluvium																							4.5+		SH
B-166+50E	13	169			Lean CLAY (CL)	Stiffer Fine Grained Alluvium	25.4	88.2	110.7																				3.75	30	MC
B-166+50E	21	161			Lean CLAY (CL)	Stiffer Fine Grained Alluvium																							4.10	31	MC
B-166+50E	35	147			Well Graded SAND with Silt and Gravel (SW-SM)	Coarse Grained Alluvium with Fines	13.3						30.5	63.3	6.2															49	SPT
B-173+50W	2	183			Lean CLAY (CL) to Lean CLAY with Gravel (CL)	Artificial Fill																							4.5+	53	MC
B-173+50W	6	179			Silty SAND (SM)	Coarse Grained Alluvium with More Fines	9.2	86.3	94.2				0.3	79.7	20.0															22	MC
B-173+50W	11	174			Lean CLAY (CL)	Stiffer Fine Grained Alluvium																							3.50	25	MC
B-173+50W	15	170			Lean CLAY (CL)	Stiffer Fine Grained Alluvium																								18	MC
B-173+50W	16	169			Lean CLAY (CL)	Stiffer Fine Grained Alluvium	19.7	105.3	126.0																				4.00		
B-173+50W	18.9	166.1			Lean CLAY (CL)	Stiffer Fine Grained Alluvium																							2.00		SH
B-173+50W	19	166			Lean CLAY (CL)	Stiffer Fine Grained Alluvium																						2200			
B-173+50W	20	165			Lean CLAY (CL)	Stiffer Fine Grained Alluvium																							2.50	24	MC
B-173+50W	25	160			Poorly Graded SAND with Silt and Gravel (SP-SM)	Coarse Grained Alluvium with Fines	13.0	117.9	133.3				22.0	66.9	11.1															55	MC
B-173+50W	34	151			Well Graded SAND with Silt and Gravel (SW-SM)	Coarse Grained Alluvium with Fines	13.3						33.6	61.9	4.5															55	SPT
B-173+50W	50	135			Lean CLAY (CL)	Stiffer Fine Grained Alluvium																							1.00	28	MC

Table 4 - Geotechnical Analyses Results
Santa Clara Valley Water District
Lower Llagas Creek Capacity Restoration Project

Analysis	Condition	Levee Slope	Analysis Cross-Section													
			Lower Llagas Creek													
			Station 50+00		Station 78+00		Station 92+50		Station 106+50		Station 126+00		Station 134+00		Station 166+50	
			West Levee	East Levee	West Levee	East Levee	West Levee	East Levee	West Levee	East Levee	West Levee	East Levee	West Levee	East Levee	West Levee	East Levee
Seepage Analysis (Exit Gradient)[1]	Design Water Surface: Steady State Seepage	Landside	0.01	0.22	0.23	0.15	0.03	0.01	0.63	0.56	N/A[3]	0.48	N/A[3]	N/A[3]	N/A[3]	N/A[3]
Seepage Analysis (FS)[2]		Landside	> 10	3.64	3.48	5.33	> 10	> 10	1.27	1.43		1.67				
Stability Analysis (FS)	Design Water Surface: Steady State Seepage	Landside	1.94	1.45	1.79	1.62	2.19	1.97	1.91	1.99	N/A[4]	2.13	N/A[4]	N/A[4]	N/A[4]	N/A[3]
	Rapid Drawdown	Waterside	1.46	1.39	1.12	1.07	1.53	1.45	1.93	1.23	2.29	1.36	1.53	2.03	1.91	1.84
	Post-Seismic	Landside	3.28	2.75	2.60	2.62	2.66	2.87	3.11	3.37	N/A[5]		N/A[5]		N/A[5]	
		Waterside	2.33	2.27	2.19	2.14	2.29	2.22	2.13	1.77						

Analysis	Condition	Station 50+00 (End-of-Construction Critical Analysis Cross-Section)				
Stability Analysis (FS)	End of Construction	**Levee Raise Alternative**	**New Levee Fill**		**Earth Retaining Structure**	
		Levee Slope	West Levee	East Levee	West Levee	East Levee
		Landside	3.02	2.66	3.68	3.08
		Waterside	2.83	2.80	3.21	3.03

[1] *Estimated at landside toe of levee. Values exceeding USACE maximum criteria of 0.5 are highlighted in red*

[2] *Factor of Safety against development of seeps and sand boils estimated at landside toe of levee.*

[3] *No levee is present at these levee sections. SEEP/W analysis used only to estimate pore pressures for use in rapid drawdown stability analysis*

[4] *No levee is present at these levee sections. Stability analysis only performed for rapid drawdown case*

[5] *No levee is present at these levee sections. No seismic analyses performed*

Appendices

Appendix A – Project Photographs

Appendix B – Field Exploration Logs and Pertinent Logs from Previous Explorations

Appendix C – Geotechnical and Environmental Laboratory Testing Results

Appendix D – Stand-Pipe Piezometer Well Completion Details

Appendix E – Seepage Analyses

Appendix F – Stability Analyses

Appendix G – Seismic Analyses

Appendix H – Settlement Evaluation

Appendix A

Project Photographs

Photo 1: Adjacent agricultural land along Reach 1 east

Photo 2: Adjacent agricultural land along Reach 2A east levee

Photo 3: Levee and Adjacent agricultural land along Reach 2A east

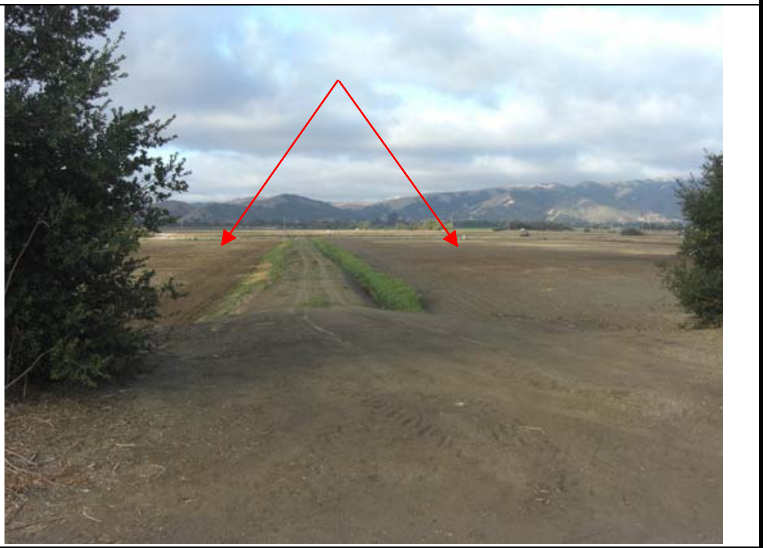


Photo 4: Adjacent SCRWA ponds along Reach 2A west

Photo 5: View of adjacent landfill along reach 2A west

Photo 6: Adjacent firing range along Reach 2A west (near Southside Drive)

Photo 7: Adjacent agricultural land along Reach 2BS west

Photo 8: Adjacent SCRWA ponds along Reach 2BS east

Photo 9: Adjacent industrial property along Reach 2BN west

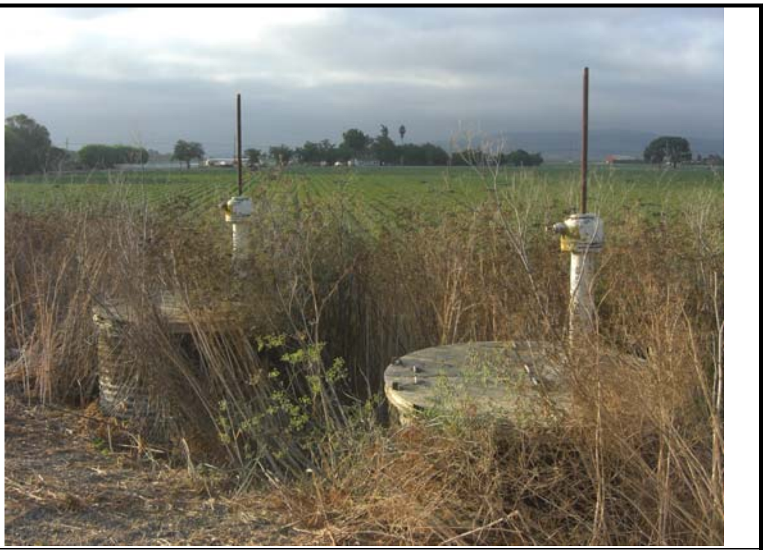


Photo 10: Control gates on levee at STA 60+00 west for agricultural drainage

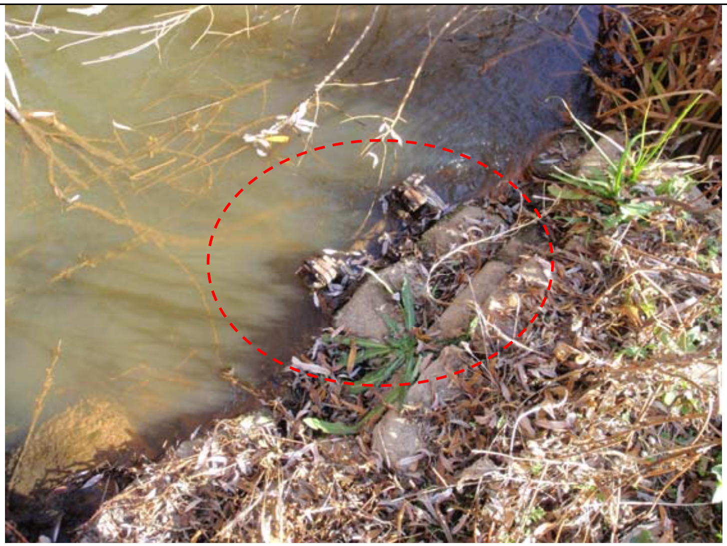


Photo 11: Flap gate outlet within Llagas Creek channel at STA 60+00 west

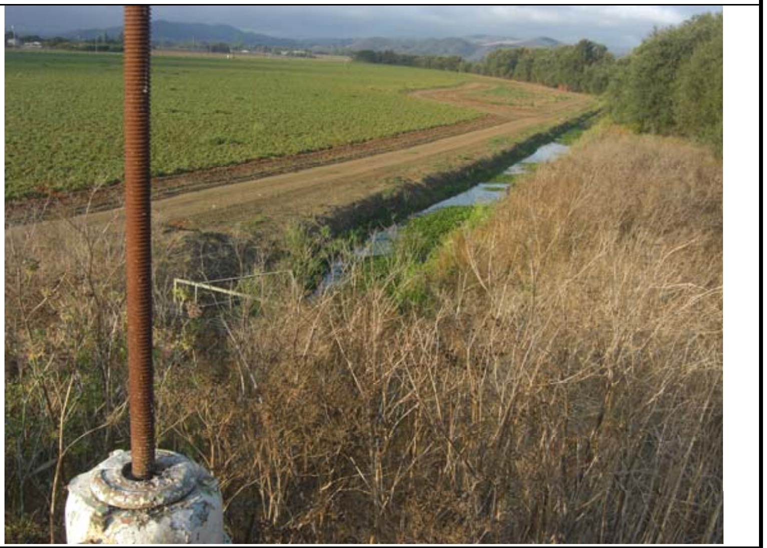


Photo 12: Agricultural drainage channel into Llagas Creek at STA 60+00 west

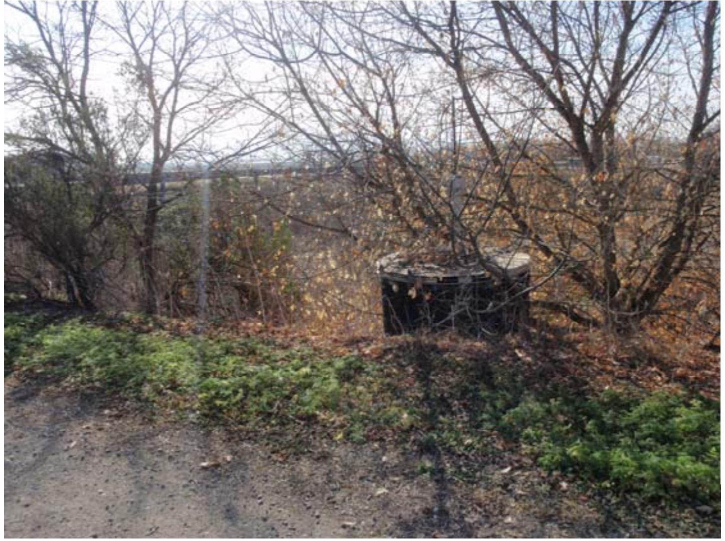


Photo 13: Drainage control on levee at STA 50+00 west for agricultural drainage

Photo 14: Miller Slough at confluence with Llagas Creek, looking west

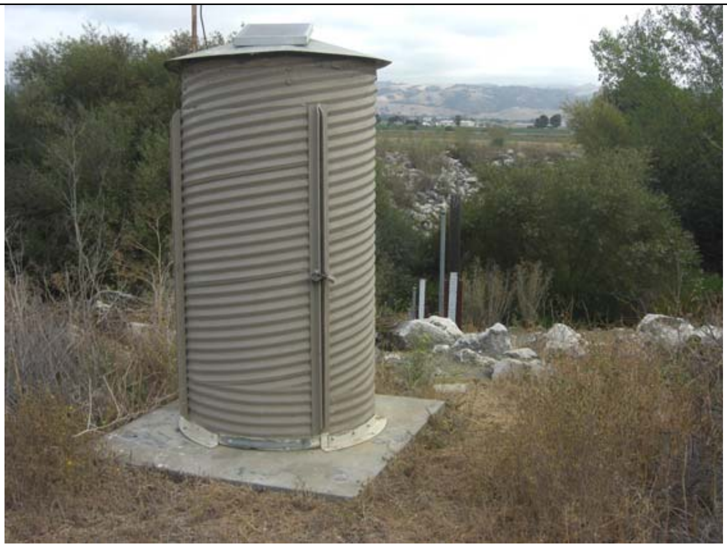


Photo 15: Active USGS stream flow monitoring station at STA 110+00 west

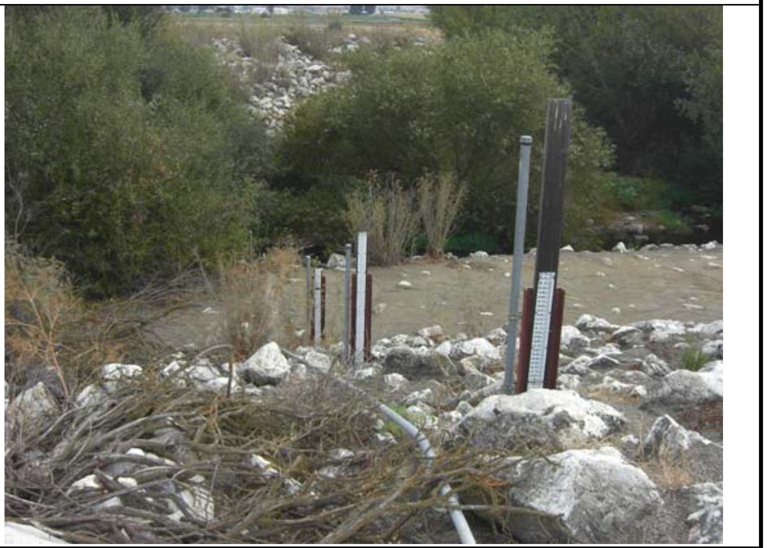


Photo 16: Active USGS stream flow monitoring station at STA 110+00 west

Photo 17: Abandoned stream flow monitoring station at STA 125+50 west

Photo 18: Vehicular bridge at Bloomfield Avenue, STA 47+00

Photo 19: Vehicular bridge at Southside Drive, STA 127+00

Photo 20: Vehicular bridge at Highway 152, STA 176+00

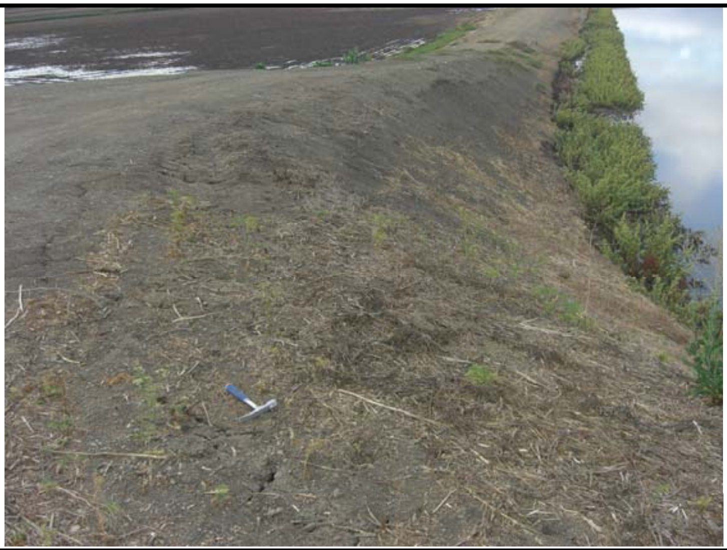


Photo 21: Observed desiccation cracks in levee fill (typical)

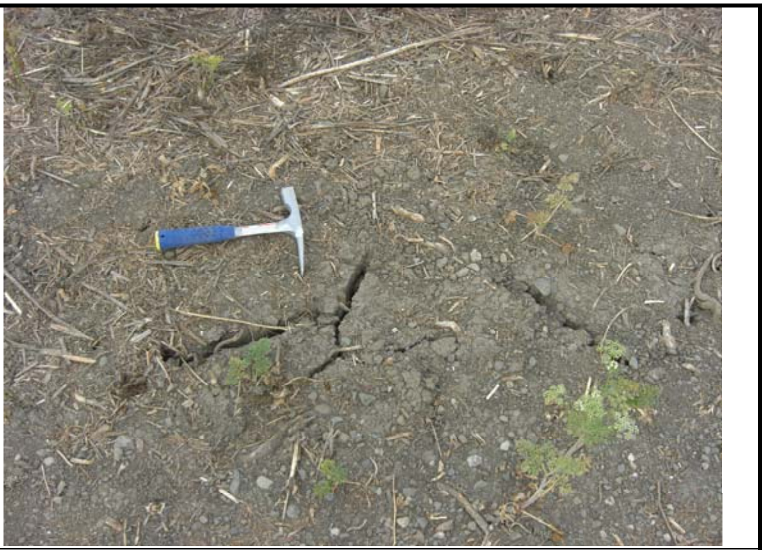


Photo 22: Observed desiccation cracks in levee fill (typical)

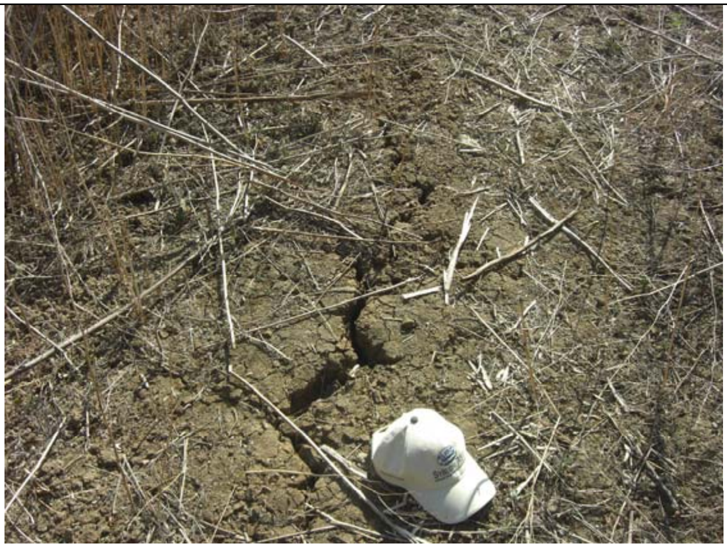


Photo 23: Observed desiccation cracks in levee fill (typical)

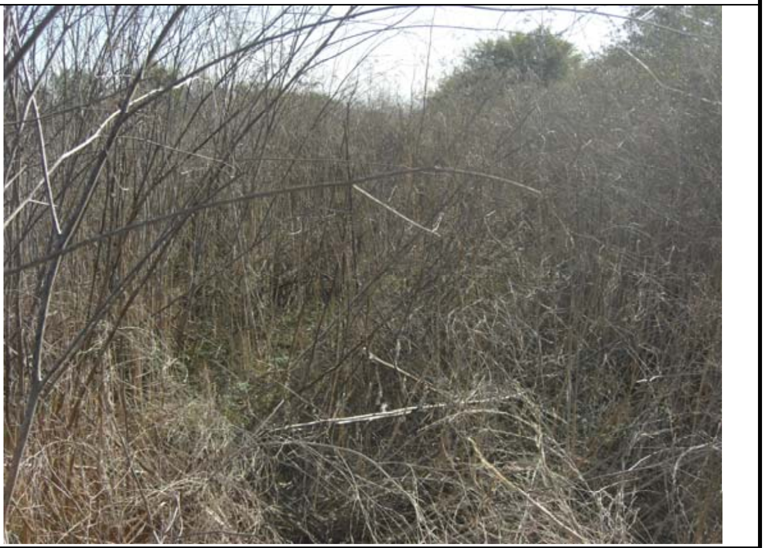


Photo 24: Dense vegetation on east levee, STA 49+00 to 108+00

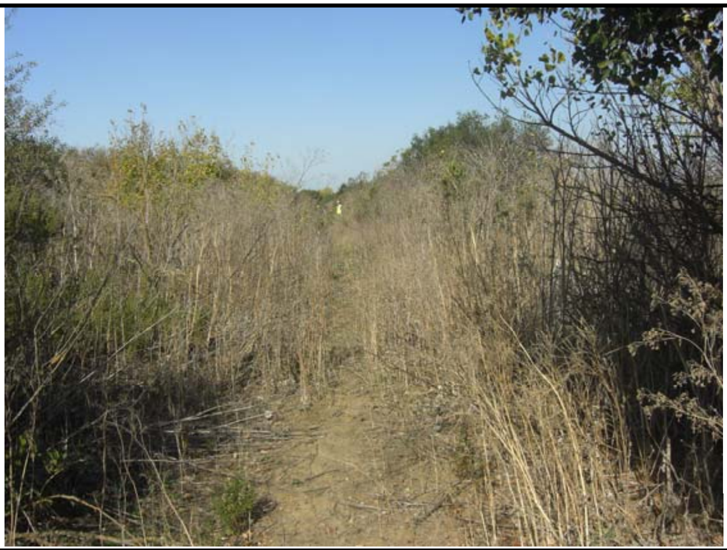


Photo 25: Dense vegetation on east levee, STA 49+00 to 108+00

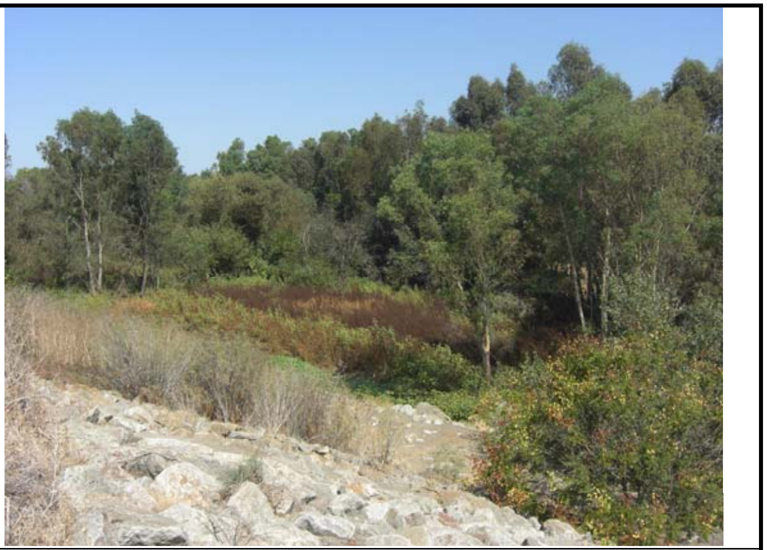


Photo 26: Typical vegetation within Llagas Creek channel

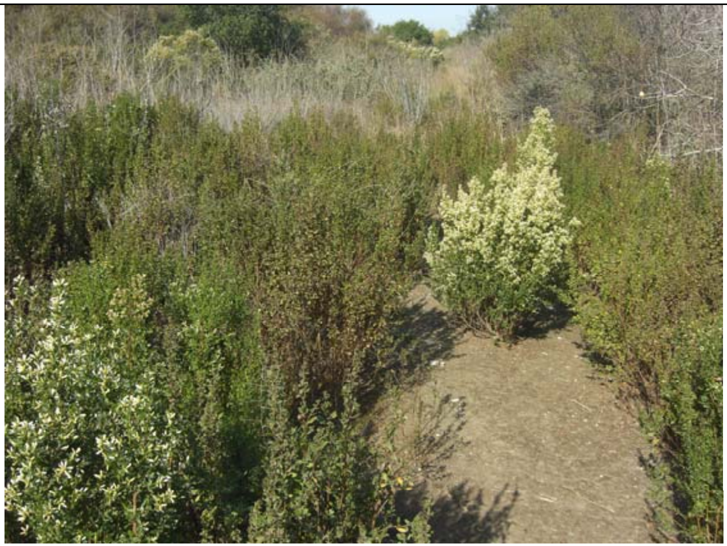


Photo 27: Dense vegetation on east levee, STA 49+00 to 108+00

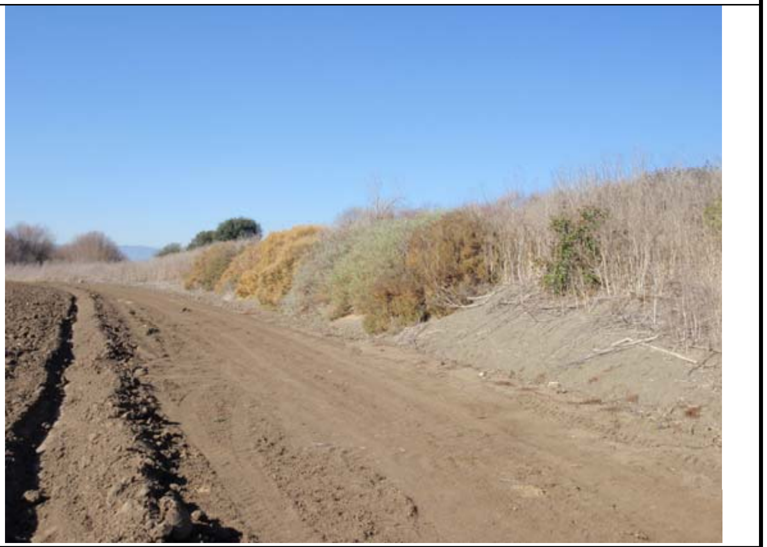


Photo 28: Typical vegetation along landside levee slopes

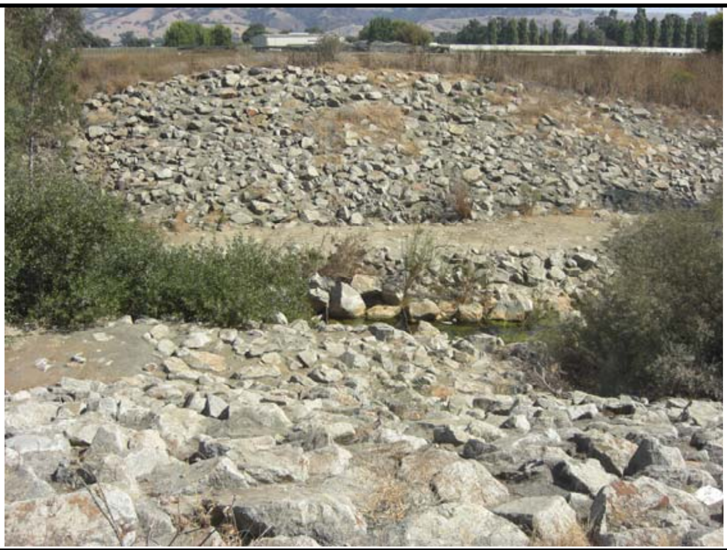


Photo 29: Rip-rap grade control structure within Reach 2BN

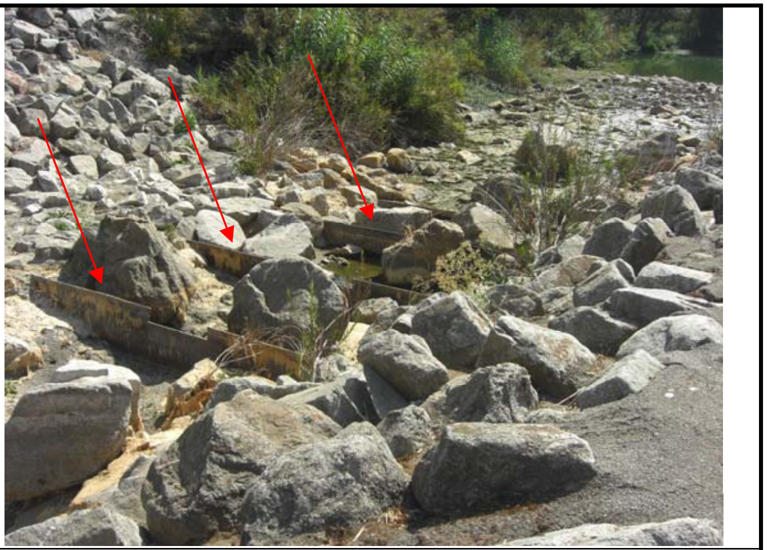


Photo 30: Rip-rap grade control structure within Reach 2BN (note weirs)

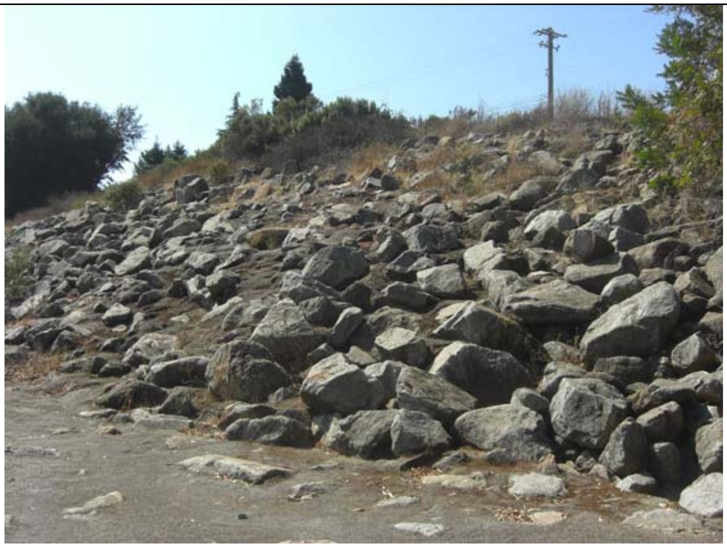


Photo 31: West slope of rip-rap grade control structure within Reach 2BN

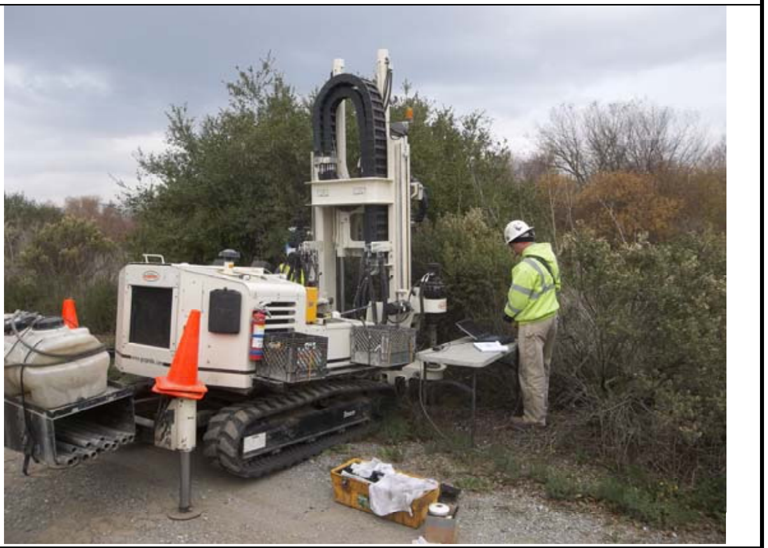


Photo 32: Typical set-up of CPT equipment during exploration program

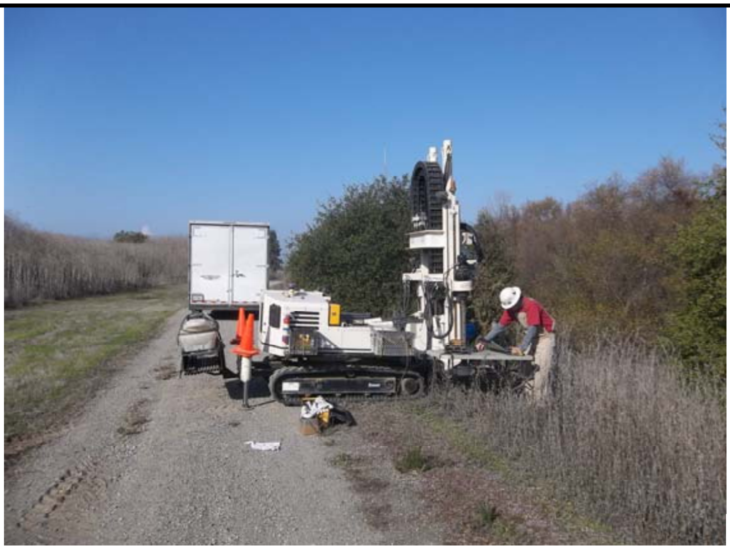


Photo 33: Typical set-up of CPT equipment during exploration program

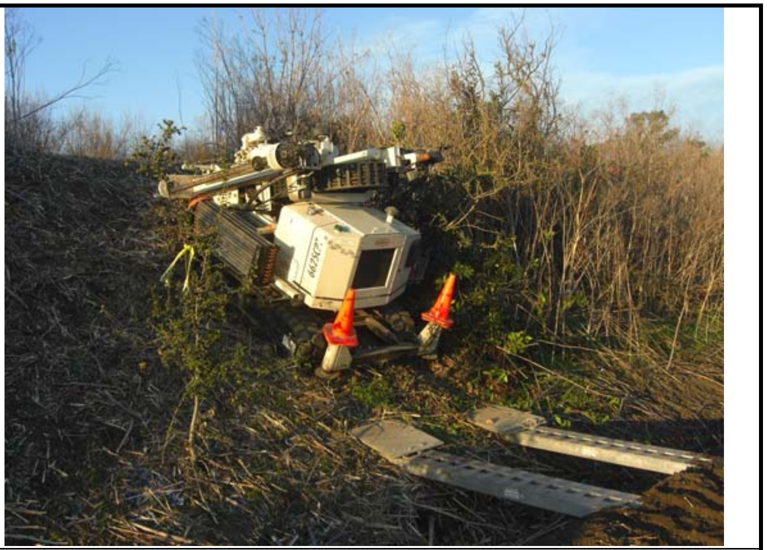


Photo 34: CPT rig tracking up slope to access CPT-92+50E

Photo 35: CPT-92+50E surface conditions after completion

Photo 36: Typical surface conditions after CPT completion

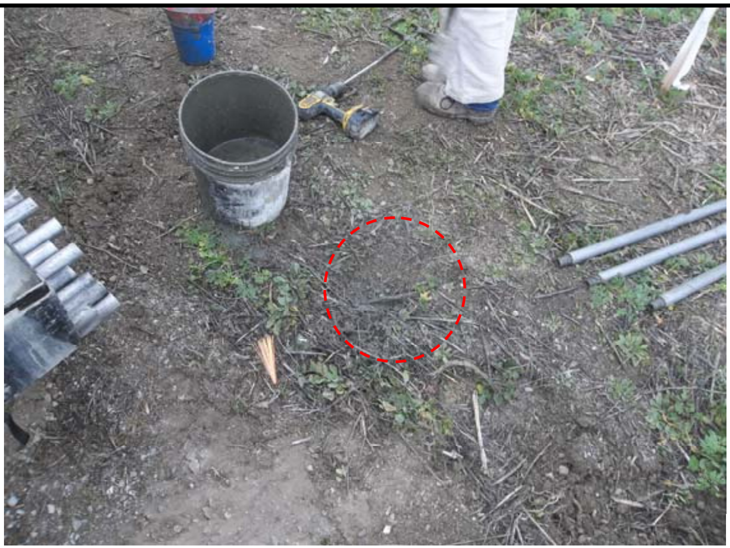


Photo 37: Completed grouting of probe hole following CPT exploration

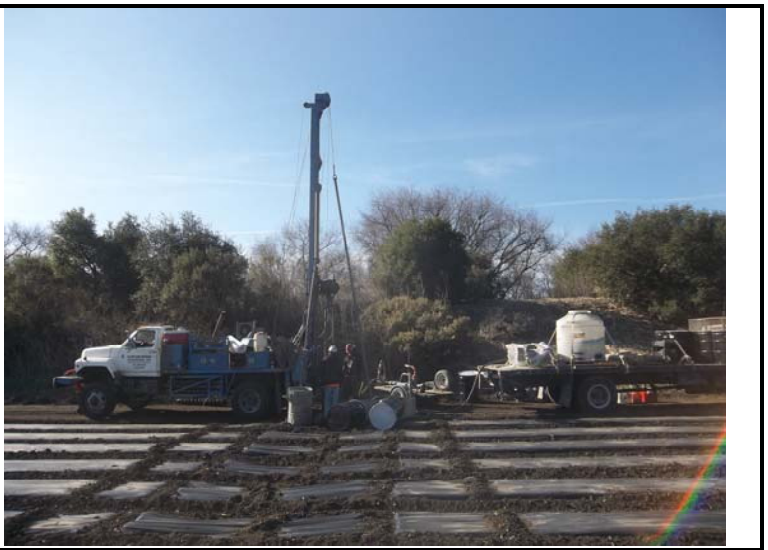


Photo 38: Typical set-up of rotary wash drilling operation

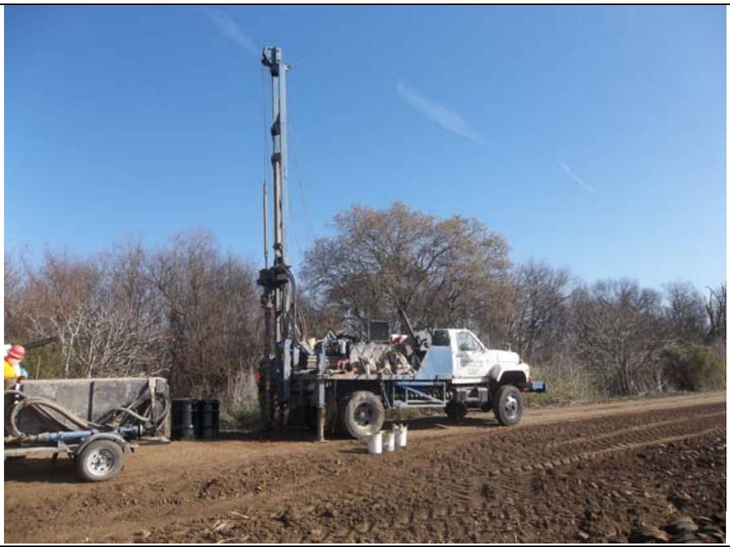


Photo 39: Typical set-up of rotary wash drilling operation

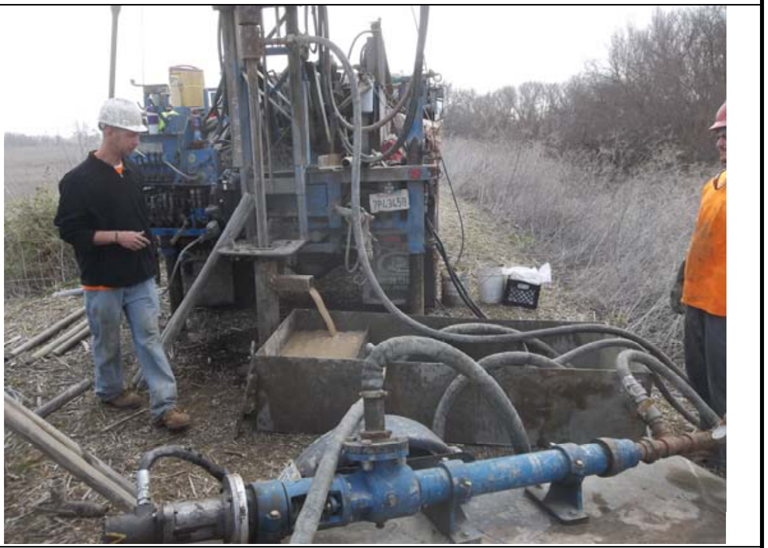


Photo 40: Drill rig, mud tub, and pump for rotary wash drilling operations

Photo 41: Screening of cuttings during rotary wash drilling operations

Photo 42: Typical set-up of hollow-stem auger drilling operation

Photo 43: Typical set-up of hollow-stem auger drilling operation

Photo 44: Drilling hollow stem auger boring along Reach 2A east

Photo 45: View of hollow-stem augers

Photo 46: Drilling hollow stem auger boring along Reach 2BS west

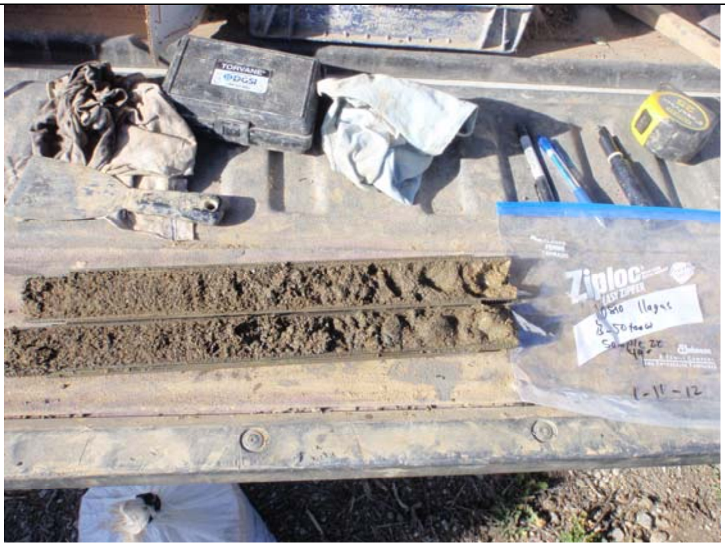


Photo 47: View of sand and gravel material within SPT sampler

Photo 48: Grouting of borehole following completion of hollow-stem boring

Photo 49: Drumming soil cuttings from boring for future testing and removal

Photo 50: Typical surface conditions following completion of drilling activities

Photo 51: Cleaning of augers between borings (fluids collected in tub below)

Photo 52: Drilling for installation of P-132+50E

Photo 53: Drilling for installation of P-173+50W

Photo 54: Slotted PVC pipe used for construction of piezometers

Photo 55: Borehole and top of piezometer casing prior to completion

Photo 56: Well cap and collar of completed P-132+50E

Photo 57: Well cap and collar of completed P-173+50W

Photo 58: Disposal of drums containing exploration soil cuttings

Photo 59: Existing District groundwater monitoring well at approx. STA 48+50E

Appendix B

Field Exploration Logs and Pertinent Logs from Previous Explorations

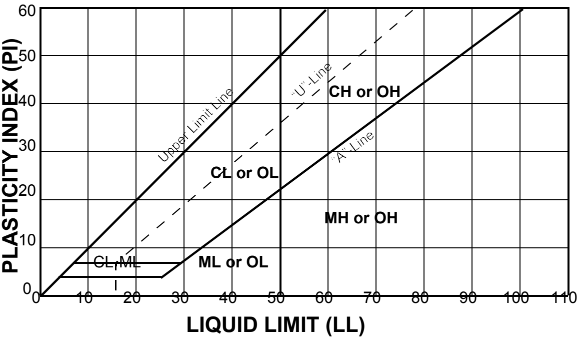
UNIFIED SOIL CLASSIFICATION SYSTEM (ASTM D-2487)

Field Identification			Group Symbols	Typical Names	Laboratory Classification Criteria			
Coarse-Grained Soils More than 50% of material is retained on the No. 200 sieve.	**Gravels** More than 50% coarse fraction retained on the No. 4 sieve	**Clean Gravels** < 5% Fines	**GW**	Well-graded gravels, gravel-sand mixtures, little or no fines	**CLASSIFICATION OF GRAVELS & SANDS WITH 5% TO 12% FINES REQUIRES DUAL SYMBOLS**	GW/GM or GP/GM: Gravel/Silty Gravel GW/GC or GP/GC: Gravel/Clayey Gravel SW/SM or SP/SM: Sand/Silty Sand SW/SC or SP/SC: Sand/Clayey Sand	$C_U = D_{60} \div D_{10} \geq 4$ and $C_C = (D_{30})^2 \div (D_{10} \times D_{60}) \geq 1 \ \& \leq 3$	
			GP	Poorly graded gravels, gravel-sand mixtures, little or no fines			$C_U = D_{60} \div D_{10} < 4$ and/or $C_C = (D_{30})^2 \div (D_{10} \times D_{60}) < 1 \ \& > 3$	
		Gravels with Fines >12% Fines	**GM**	Silty gravels, poorly graded gravel-sand-silt mixtures			Fines classify as ML or MH	If fines classify as CL-ML, use dual symbol GC/GM
			GC	Clayey gravels, poorly graded gravel-sand-clay mixtures			Fines classify as CL or CH	
	Sands More than 50% coarse fraction passes the No. 4 sieve	**Clean Sands** < 5% Fines	**SW**	Well-graded sands, gravelly sands, little or no fines			$C_U = D_{60} \div D_{10} \geq 6$ and $C_C = (D_{30})^2 \div (D_{10} \times D_{60}) \geq 1 \ \& \leq 3$	
			SP	Poorly graded sands, gravelly sands, little or no fines			$C_U = D_{60} \div D_{10} < 6$ and/or $C_C = (D_{30})^2 \div (D_{10} \times D_{60}) < 1 \ \& > 3$	
		Sands with Fines >12% Fines	**SM**	Silty sands, poorly graded sand-silt mixtures			Fines classify as ML or MH	If fines classify as CL-ML, use dual symbol SC/SM
			SC	Clayey sands, poorly graded sand-clay mixtures			Fines classify as CL or CH	
Fine-Grained Soils More than 50% of material passes the No. 200 sieve.	**Identification Procedures on Percentage Passing the No. 40 Sieve**							
	Silts & Clays Liquid Limit less than 50%		**ML**	Inorganic silts, very fine sands, rock flour, silty or clayey fine sands with slight plasticity				
			CL	Inorganic clays of low to medium plasticity, gravelly, sandy, and/or silty clays, lean clays				
			OL	Organic silts, organic silty clays of low plasticity				
	Silts & Clays Liquid Limit greater than 50%		**MH**	Inorganic silts, micaceous or diatomaceous fine sandy/-silty soil, elastic silts				
			CH	Inorganic clays of high plasticity, fat clays				
			OH	Organic clays of medium to high plasticity				
HIGHLY ORGANIC SOILS			**PT**	Peat and other highly organic soils				

PLASTICITY CHART

For Classification of Fine-Grained Soils and Fine-Grained Fraction of Coarse-Grained Soils

Equation of "A"-Line: PI = 4 @ LL = 4 to 25.5, then PI = 0.73 × (LL − 20)
Equation of "U"-Line: LL = 16 @ PI = 0 to 7, then PI = 0.9 × (LL − 8)



KEY TO SAMPLER TYPES AND OTHER LOG SYMBOLS

CS	California Standard Sampler
CM	California Modified Sampler
SPT	Standard Penetration Test Sampler
SHL	Shelby Tube Sampler
BU	Bulk Sample
LL	Liquid Limit of Sample (ASTM D-4318)
PI	Plasticity Index of Sample (ASTM D-4318)
Q_U	Unconfined Compression Test (ASTM D-2166)

▽	Depth at which Groundwater was Encountered During Drilling
▼	Depth at which Groundwater was Measured After Drilling
PP	Pocket Penetrometer Test
PTV	Pocket Torvane Test
-#200	% of Material Passing the No. 200 Sieve Test (ASTM D-1140)
PSA	Particle-Size Analysis (ASTM D-422 & D-1140)
C	Consolidation Test (ASTM D-2435)
TXUU	Unconsolidated Undrained Compression Test (ASTM D-2850)

KEY TO SAMPLE INTERVALS

CS	Length of Sampler Interval with a CS Sampler
■	Length of Sampler Interval with a CM Sampler
◫	Length of Sampler Interval with a SPT Sampler
SHL	Length of Sampler Interval with a SHL Sampler

BU	Bulk Sample Recovered for Interval Shown (i.e., cuttings)
⌶	Length of Coring Run with Core Barrel Type Sampler
NR	No Sample Recovered for Interval Shown

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UNIFIED SOIL CLASSIFICATION SYSTEM AND KEY TO BORING LOG

BORING NUMBER B-050+00W

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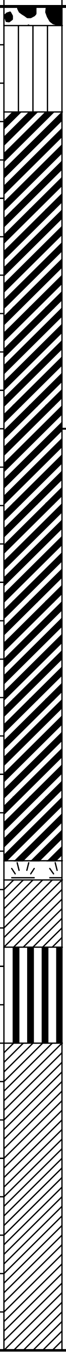
CLIENT	SCVWD c/o GEI Consultants	**PROJECT NAME**	Lower Llagas Creek Restoration Project
PROJECT NUMBER	110810	**PROJECT LOCATION**	Between HWY 152 and Bloomfield Ave., Gilroy, CA
DATE STARTED	1/11/2012 **COMPLETED** 1/11/2012	**GROUND ELEVATION**	154 ft **HOLE SIZE** 6 in.
DRILLING CONTRACTOR	EXPLORATION GEOSERVICES	**GROUND WATER LEVELS:**	
DRILLING METHOD	6-inch HOLLOWSTEM AUGER	▽ **AT TIME OF DRILLING**	24.0 ft / Elev 130.0 ft
LOGGED BY	D. BURGER **CHECKED BY**	**AT END OF DRILLING**	---
NOTES	Hammer Type: 140#/30" cabledrop	**AFTER DRILLING**	---



DEPTH (ft)	MATERIAL DESCRIPTION	SAMPLE TYPE	BLOW COUNTS (FIELD VALUE)	POCKET PEN. (tsf)	DRY UNIT WT. (pcf)	MOISTURE CONTENT (%)	ATTERBERG LIMITS LIQUID LIMIT (%)	ATTERBERG LIMITS PLASTIC LIMIT (%)	ATTERBERG LIMITS PLASTICITY INDEX (%)	FINES CONTENT (%)
0	Approximately 6 in. of gravel (ARTIFICIAL FILL)									
	CLAYEY SILT (ML), brown, dry (LEVEE FILL)									
		CM	9-12-10	4.5+						
	FAT CLAY (CH), very dark brown, slightly moist, hard, medium to high plasticity, less than 5% sand	SPT	5-8-10							
5	FAT CLAY (CH), brown gray with red brown mottling, dry, very stiff, very fine sand less than 10%, iron stains **(Bulk sample 4-9 ft: TX-CU-P, compaction curve, hydraulic conductivity)**									
	FAT CLAY (CH), black and brown and grades to dark gray, dry to slightly moist, hard, little silt, less than 10% very fine to fine sand	CM	7-11-13	4.5+						
	FAT CLAY (CH), gray brown with light brown, moist, stiff, less than 5% rounded gravel up to 1/4 in., trace very fine to medium sand, medium to high plasticity	SPT	3-5-7							
10	FAT CLAY (CH), dark gray grades to black, slightly moist, very stiff, medium to plasticity, isolated gravel up to 1 in. at 11-11.5 ft	CM	4-7-11	2.30						
	FAT CLAY (CH), black, moist, medium stiff, soft consistency, high plasticity, dilatancy slow to none, pocket torvane=0.35tsf at 14 ft (ALLUVIUM) **(TX-UU)**	SH		0.75	84	37	55	25	30	
15	FAT CLAY (CH), very dark gray to black, moist, stiff, high plasticity	CM	5-8-12	1.25						
	FAT CLAY (CH), black to very dark gray, moist, stiff, firm consistency, high plasticity, pocket torvane=0.42tsf at 18 ft. **(TX-CU-P)**	SH		1.00	75	45	64	31	33	
		CM	3-3-5							
20	FAT CLAY (CH), dark gray, moist, stiff, high plasticity, iron stains			1.00	58	70				
	FAT CLAY (CH), dark green gray to dark gray, moist, soft, very soft consistency, high plasticity, pocket torvane=0.28tsf at 22 ft **(TX-UU, consolidation)**	SH		0.30	62	63	92	32	60	
	PEAT (PT), black to very dark brown, wet **(Organic content)**	CM	3-5-8	1.00	20	253				
▽	LEAN CLAY (CL), very dark gray, moist to wet, stiff, some organic content and silt									
25	ELASTIC SILT (MH), black, moist to wet, stiff, some silt and organic content **(TX-UU)**	CM	3-5-9	1.25	46	93	86	45	42	
30	LEAN CLAY (CL), green gray grades to dark gray, moist, medium stiff, firm consistency, medium plasticity	CM	4-6-7	0.75						
35	LEAN CLAY (CL), gray, moist, stiff, firm consistency, medium plasticity,	CM	6-8-13							

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BORING NUMBER B-050+00W

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CLIENT SCVWD c/o GEI Consultants

PROJECT NAME Lower Llagas Creek Restoration Project

PROJECT NUMBER 110810

PROJECT LOCATION Between HWY 152 and Bloomfield Ave., Gilroy, CA

DEPTH (ft)	GRAPHIC LOG	MATERIAL DESCRIPTION	SAMPLE TYPE	BLOW COUNTS (FIELD VALUE)	POCKET PEN. (tsf)	DRY UNIT WT. (pcf)	MOISTURE CONTENT (%)	ATTERBERG LIMITS			FINES CONTENT (%)
								LIQUID LIMIT (%)	PLASTIC LIMIT (%)	PLASTICITY INDEX (%)	
35		dilatancy slow, less than 5% sand			1.25						
40		LEAN CLAY (CL), dark green gray, moist to wet, stiff, medium plasticity, dilatancy slow to none, less than 5% sand	CM	8-11-14	1.40						
		LEAN CLAY (CL) to LEAN CLAY with SAND (CL), gray green, moist, stiff, very fine sand, grades to silt									
45		SANDY SILT (ML), olive brown gray, moist, stiff, very fine to fine sand approximately 40%, low plasticity	CM	8-10-14							
		Assumed contact POORLY GRADED SAND (SP), gray brown, wet, dense to very dense, medium to very coarse sand									
50			SPT	15-24-40			18				4
		POORLY GRADED GRAVEL with SAND (GP), gray brown, wet, very dense, rounded gravel up to 1.5 in., trace fines									
55		POORLY GRADED SAND with SILT and GRAVEL (SP-SM), brown gray, wet, very dense, subangular to subrounded gravel up to 3/4 in., fine to very coarse sand	SPT	14-24-50							
		POORLY GRADED SAND with SILT (SP-SM), gray, wet, medium dense, very fine to medium sand									
60		LEAN CLAY (CL) to LEAN CLAY with SAND (CL), gray, wet, firm consistency, medium stiff	SPT	9-9-19	1.00						
		POORLY GRADED SAND with SILT (SP-SM)									

Bottom of borehole at 60.5 ft. Borehole backfilled with grout.

BORING NUMBER B-059+00W

CLIENT SCVWD c/o GEI Consultants
PROJECT NAME Lower Llagas Creek Restoration Project
PROJECT NUMBER 110810
PROJECT LOCATION Between HWY 152 and Bloomfield Ave., Gilroy, CA
DATE STARTED 1/11/2012 **COMPLETED** 1/11/2012
GROUND ELEVATION 155 ft **HOLE SIZE** 6 in.
DRILLING CONTRACTOR EXPLORATION GEOSERVICES
GROUND WATER LEVELS:
DRILLING METHOD 6-inch HOLLOWSTEM AUGER
∇ **AT TIME OF DRILLING** 21.0 ft / Elev 134.0 ft
LOGGED BY D. BURGER **CHECKED BY**
AT END OF DRILLING ---
NOTES Hammer Type: 140#/30" cabledrop
AFTER DRILLING ---

DEPTH (ft)	GRAPHIC LOG	MATERIAL DESCRIPTION	SAMPLE TYPE	BLOW COUNTS (FIELD VALUE)	POCKET PEN. (tsf)	DRY UNIT WT. (pcf)	MOISTURE CONTENT (%)	ATTERBERG LIMITS LIQUID LIMIT (%)	ATTERBERG LIMITS PLASTIC LIMIT (%)	ATTERBERG LIMITS PLASTICITY INDEX (%)	FINES CONTENT (%)
0		Approximately 6 in. of gravel (ARTIFICIAL FILL)									
		FAT CLAY (CH) to FAT CLAY with GRAVEL (CH), dark grayish brown, dry to slightly moist, hard, trace sand (LEVEE FILL)	CM	9-11-12	4.5+						
		FAT CLAY (CL), dark brown, slightly moist, stiff, rounded gravel up to 3/8 in. less than 10%, trace very fine sand	SPT	6-5-7							
5		FAT CLAY (CH), dark brown, dry to slightly moist, hard, trace organic stringers near top of sample, trace very fine sand **(UC)**	CM	11-12-19	4.50	92	26	71	26	45	
		FAT CLAY (CH), dark brown, moist, stiff, medium to high plasticity, less than 5% sand	SPT	5-6-5							
10		FAT CLAY (CH), gray brown, moist, very stiff, medium to high plasticity **(TX-UU)**	SH		2.90	90	33				
		FAT CLAY (CH), dark brown grades to brown, moist, hard, medium to high plasticity, less than 5% sand, dilatancy slow to none	CM	12-17-23	4.25						
15		LEAN CLAY (CL), very dark gray to black, moist, soft consistency, medium plasticity, pocket torvane=0.4tsf at 16 ft (ALLUVIUM) **(TX-UU, consolidation)**	SH		0.60	103 103	21 23	40	20	20	
		FAT CLAY (CH), very dark green gray, moist, stiff, high plasticity	CM	6-9-11	1.40						
20		LEAN to FAT CLAY (CL/CH), grades to peat PEAT (PT), black to dark brown, wet, stiff **(TX-UU, organic content)**	CM	4-6-12		23	214 194				
25		FAT CLAY (CH), dark gray, moist to wet, stiff, high plasticity	CM	6-8-8	1.20	79	44	54	25	29	
30		POORLY GRADED GRAVEL with SILT and SAND (GP-GM), dark green gray, wet, very dense, rounded to subrounded gravel up to 1 in., fine to very coarse sand	CM	13-18-25							
35		LEAN CLAY (CL), brown, moist to wet, very stiff, medium plasticity, less	SPT	6-9-12							

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BORING NUMBER B-059+00W

CLIENT SCVWD c/o GEI Consultants
PROJECT NAME Lower Llagas Creek Restoration Project
PROJECT NUMBER 110810
PROJECT LOCATION Between HWY 152 and Bloomfield Ave., Gilroy, CA

DEPTH (ft)	MATERIAL DESCRIPTION	SAMPLE TYPE	BLOW COUNTS (FIELD VALUE)	POCKET PEN. (tsf)	DRY UNIT WT. (pcf)	MOISTURE CONTENT (%)	ATTERBERG LIMITS LIQUID LIMIT (%)	ATTERBERG LIMITS PLASTIC LIMIT (%)	ATTERBERG LIMITS PLASTICITY INDEX (%)	FINES CONTENT (%)
35	than 5% sand									
	LEAN CLAY (CL), gray, wet, stiff, grades to gravel									
40	POORLY GRADED GRAVEL with SILT and SAND (GP-GM), brown gray, wet, dense, fine to very coarse sand, grades to silty sand	CM	10-13-25							
	SILTY SAND (SM), brown, wet, dense, fine to medium sand									
45	POORLY GRADED SAND with SILT and GRAVEL (SP-SM), brown to gray brown, wet, very dense, fine to very coarse sand, angular to subangular gravel up to 1/2 in.	SPT	39-50			11				10
50	LEAN CLAY (CL), brown, moist, hard, medium plasticity, less than 5% sand	SPT	10-14-27							
55	LEAN CLAY (CL), gray brown, moist to wet, stiff, medium plasticity	CM	11-30-29	1.90						
60	LEAN CLAY (CL), olive gray brown, moist to wet, stiff, medium plasticity, grades to silt	SPT	7-6-9							
	SILT (ML), olive gray brown, wet, stiff, very fine sand, low plasticity									

Bottom of borehole at 60.5 ft. Borehole backfilled with grout.

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BORING NUMBER B-065+00E

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CLIENT SCVWD c/o GEI Consultants
PROJECT NAME Lower Llagas Creek Restoration Project
PROJECT NUMBER 110810
PROJECT LOCATION Between HWY 152 and Bloomfield Ave., Gilroy, CA
DATE STARTED 1/3/2012 **COMPLETED** 1/3/2012
GROUND ELEVATION 158 ft **HOLE SIZE** 6 in.
DRILLING CONTRACTOR EXPLORATION GEOSERVICES
GROUND WATER LEVELS:
DRILLING METHOD ROTARY WASH
AT TIME OF DRILLING --- Groundwater not determined
LOGGED BY D. BURGER **CHECKED BY**
AT END OF DRILLING ---
NOTES Hammer Type: 140#/30" cabledrop
AFTER DRILLING ---

DEPTH (ft)	MATERIAL DESCRIPTION	SAMPLE TYPE	BLOW COUNTS (FIELD VALUE)	POCKET PEN. (tsf)	DRY UNIT WT. (pcf)	MOISTURE CONTENT (%)	ATTERBERG LIMITS LIQUID LIMIT (%)	ATTERBERG LIMITS PLASTIC LIMIT (%)	ATTERBERG LIMITS PLASTICITY INDEX (%)	FINES CONTENT (%)
0	SILT (ML), brown, slightly moist to dry (LEVEE FILL)									
	FAT CLAY (CH), dark brown, slightly moist, hard, organic stringers, little silt, trace very fine sand **(UC)**	CM	18-24-26	4.5+	112	14				
	FAT CLAY with GRAVEL (CH), dark brown, moist, stiff consistency, lenses of fat clay, very fine sand in silty lenses	SPT	10-10-7							
5										
	FAT CLAY (CH), dark brown, moist, stiff consistency, medium to high plasticity, trace sand FAT CLAY (CH), claystone rock fragments	CM	14-16-16							
	FAT CLAY (CH) to FAT CLAY with SAND (CH), brown, slightly moist, stiff, trace fine to coarse gravel, very fine to fine sand	SPT	10-7-5							
	FAT CLAY with GRAVEL (CH), very dark brown, moist, stiff consistency, rounded gravel up to 3/8 in., trace very fine sand **(UC)**	CM	6-8-9		108 93	13 25	55	21	34	
10										
	FAT CLAY (CH), brown, moist, stiff, very fine to fine sand up to 10%	SPT	5-8-7							
	LEAN to FAT CLAY (CL/CH), dark gray to black, moist, very stiff, stiff consistency, trace angular gravel, iron stains **(UC)**	CM	8-12-15	3.80	97	27				
	FAT CLAY (CH), dark gray, moist, stiff, high plasticity, trace organices, trace very fine sand near bottom of sample (ALLUVIUM)	SPT	4-7-10							
15										
	LEAN CLAY (CL), dark gray, moist to wet, stiff, medium plasticity, dilatancy slow, trace sand **(TX-UU)**	SH			105	22	38	19	19	
	LEAN CLAY (CL), dark gray, moist to wet, stiff	CM	7-14-16	2.30						
20										
		CM	7-10-11		55	125 72				
	CLAYEY PEAT to PEAT (PT), brownish black to dark brown, wet, stiff, minor iron stains, minor odor **(TX-UU, organic content)**									
	Driller indicated stiffer drilling at 22.5 ft									
25										
	LEAN CLAY (CL), gray to dark gray, moist to wet, medium stiff, firm consistency, medium plasticity, less than 5% sand, pocket torvane=0.61tsf at 26 ft	CM	4-7-10	1.00						
	ELASTIC SILT (MH), blue gray, moist to wet, medium plasticity, trace very fine sand, slow to rapid dilatancy									
30										
	LEAN CLAY (CL) to LEAN CLAY with SAND (CL), dark gray grades to green gray, moist to wet, stiff, firm consistency, medium plasticity, slow dilatancy, very fine to fine sand up to 15% near bottom of sample	CM	7-9-12	1.60	100	25				
35										

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BORING NUMBER B-065+00E

CLIENT SCVWD c/o GEI Consultants

PROJECT NAME Lower Llagas Creek Restoration Project

PROJECT NUMBER 110810

PROJECT LOCATION Between HWY 152 and Bloomfield Ave., Gilroy, CA

DEPTH (ft)	GRAPHIC LOG	MATERIAL DESCRIPTION	SAMPLE TYPE	BLOW COUNTS (FIELD VALUE)	POCKET PEN. (tsf)	DRY UNIT WT. (pcf)	MOISTURE CONTENT (%)	ATTERBERG LIMITS LIQUID LIMIT (%)	ATTERBERG LIMITS PLASTIC LIMIT (%)	ATTERBERG LIMITS PLASTICITY INDEX (%)	FINES CONTENT (%)
35	▨	LEAN CLAY (CL), green blue gray, moist to wet, firm consistency, medium stiff, less than 10% very fine sand, grades to brown, moist, very stiff	CM	4-9-15	0.80 2.90						
40	▨	SANDY LEAN CLAY (CL), light brown, moist to wet, stiff consistency, lenses of silty sand, medium to low plasticity, very fine to medium sand, iron stains	CM	12-14-18							
	●	Driller indicated sand and gravel at 42 ft									
45	●	WELL GRADED GRAVEL with SAND (GW), brown, wet, very dense, fine to coarse sand, rounded to subrounded gravel up to 1/2 in.	CM	38-50		127	10				5
50	●	Approximately 8 ft of sluff in hole, driller indicated gravel and sand larger than 3/4 in.									

Bottom of borehole at 51.5 ft. Borehole backfilled with grout.

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BORING NUMBER B-078+00W

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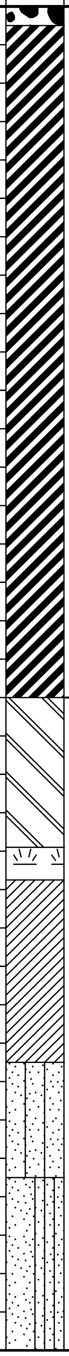
CLIENT SCVWD c/o GEI Consultants
PROJECT NAME Lower Llagas Creek Restoration Project
PROJECT NUMBER 110810
PROJECT LOCATION Between HWY 152 and Bloomfield Ave., Gilroy, CA
DATE STARTED 1/10/2012 **COMPLETED** 1/10/2012
GROUND ELEVATION 164 ft **HOLE SIZE** 6 in.
DRILLING CONTRACTOR EXPLORATION GEOSERVICES
GROUND WATER LEVELS:
DRILLING METHOD 6-inch HOLLOWSTEM AUGER
∇ **AT TIME OF DRILLING** 28.0 ft / Elev 136.0 ft
LOGGED BY D. BURGER **CHECKED BY**
AT END OF DRILLING ---
NOTES Hammer Type: 140#/30" cabledrop
AFTER DRILLING ---

DEPTH (ft)	GRAPHIC LOG	MATERIAL DESCRIPTION	SAMPLE TYPE	BLOW COUNTS (FIELD VALUE)	POCKET PEN. (tsf)	DRY UNIT WT. (pcf)	MOISTURE CONTENT (%)	ATTERBERG LIMITS LIQUID LIMIT (%)	ATTERBERG LIMITS PLASTIC LIMIT (%)	ATTERBERG LIMITS PLASTICITY INDEX (%)	FINES CONTENT (%)
0		Approximately 4-6 in. of gravel (ARTIFICIAL FILL)									
		FAT CLAY (CH), brown, moist, few to little silt and sand (LEVEE FILL)									
		FAT CLAY (CH) to FAT CLAY with SAND (CH), brown, slightly moist to dry, grades to lean clay, very dark brown, slightly moist, very stiff, medium to high plasticity, trace very fine sand	CM	6-9-12	3.20						
5		FAT CLAY (CH), very dark gray to black, slightly moist, stiff, medium to high plasticity	SPT	4-5-7							
		FAT CLAY (CH), dark green gray and dark gray, slightly moist, hard, very fine to fine sand, trace rounded fine gravel **(UC)**	CM	4-9-12	4.5+	91	31	62	23	40	
10		FAT CLAY (CH), mottling of dark gray and light brown, slightly moist, stiff, less than 5% sand	SPT	5-6-6							
		FAT CLAY (CH), very dark gray grades to olive to brown green, moist, hard, medium to high plasticity, trace sand	CM	6-9-13	4.25						
15		FAT CLAY (CH), dark gray, grades to light brown, moist, very stiff, less than 5% sand, medium to high plasticity	SPT	4-6-12							
		FAT CLAY (CH), very dark gray to black grades to very dark green gray with brown mottling, slightly moist, very stiff, less than 10% sand, subrounded to subangular gravel up to 3/4 in. **(UC)**	CM	6-12-15	3.20	101	25	52	23	29	
20		FAT CLAY (CH), very dark gray to black, slightly moist, very stiff, trace sand nodules (ALLUVIUM)	SPT	6-7-9							
		LEAN CLAY (CL), black to very dark brown, moist, stiff, peat/organics at bottom of sample, medium plasticity clay, pocket torvane=0.5tsf at 21.9 ft	SH		1.80						
		Wood/peat (PT) material	CM	7-8-11							
25		LEAN CLAY (CL), very dark gray, moist, very stiff, medium plasticity, dilatancy slow				99	26				
		LEAN CLAY (CL), dark green gray, moist, medium stiff, less than 10% very fine sand, some silt, medium plasticity, firm to soft consistency, pocket torvane=0.44tsf at 27 ft **(TX-CU-P, consolidation)**	SH		0.75	57	65	40	16	24	
	∇	SILTY SAND (SM), green gray, moist to wet, medium dense, very fine to fine sand	CM	4-6-9							
30		SILTY SAND (SM), dark green, wet, medium dense, very fine to coarse sand	SPT	6-7-12			24				23
35		POORLY GRADED SAND (SP) to POORLY GRADED SAND with SILT	SPT	7-13-14							

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CAL ENGINEERING & GEOLOGY

BORING NUMBER B-078+00W

CLIENT SCVWD c/o GEI Consultants

PROJECT NAME Lower Llagas Creek Restoration Project

PROJECT NUMBER 110810

PROJECT LOCATION Between HWY 152 and Bloomfield Ave., Gilroy, CA

DEPTH (ft)	GRAPHIC LOG	MATERIAL DESCRIPTION	SAMPLE TYPE	BLOW COUNTS (FIELD VALUE)	POCKET PEN. (tsf)	DRY UNIT WT. (pcf)	MOISTURE CONTENT (%)	ATTERBERG LIMITS			FINES CONTENT (%)
								LIQUID LIMIT (%)	PLASTIC LIMIT (%)	PLASTICITY INDEX (%)	
35		(SP-SM), dark olive brown gray, wet, dense, very fine to coarse sand									
		POORLY GRADED GRAVEL with SAND (GP), green gray, wet, dense, angular to subangular gravel up to 1/2 in.									
40		WELL GRADED SAND with SILT and GRAVEL (SW-SM), brown gray, wet, very dense, fine to coarse sand, rounded to subrounded gravel up to 3/4 in.	SPT	14-30-35			11				9
45		LEAN CLAY (CL), light brown, moist to wet, very stiff, medium plasticity, trace very fine sand	SPT	9-12-16							
50		SILT (ML), light brown, wet, firm consistency, stiff to medium stiff, less than 15% very fine sand	CM	4-5-8	1.00	102	25				
55		LEAN CLAY (CL), light brown, wet, stiff, firm consistency, trace very fine sand, medium plasticity	CM	5-8-13	1.25						
60		LEAN CLAY (CL), light brown, moist, stiff, medium plasticity, little silt	CM	11-15-22	1.25						

Bottom of borehole at 60.5 ft. Borehole backfilled with grout.

BORING NUMBER B-092+50E

PAGE 1 OF 2

CLIENT SCVWD c/o GEI Consultants
PROJECT NAME Lower Llagas Creek Restoration Project
PROJECT NUMBER 110810
PROJECT LOCATION Between HWY 152 and Bloomfield Ave., Gilroy, CA
DATE STARTED 1/4/2012 **COMPLETED** 1/4/2012
GROUND ELEVATION 150 ft **HOLE SIZE** 6 in.
DRILLING CONTRACTOR EXPLORATION GEOSERVICES
GROUND WATER LEVELS:
DRILLING METHOD ROTARY WASH
AT TIME OF DRILLING --- Groundwater not determined
LOGGED BY D. BURGER **CHECKED BY**
AT END OF DRILLING ---
NOTES Hammer Type: 140#/30" cabledrop
AFTER DRILLING ---

DEPTH (ft)	GRAPHIC LOG	MATERIAL DESCRIPTION	SAMPLE TYPE	BLOW COUNTS (FIELD VALUE)	POCKET PEN. (tsf)	DRY UNIT WT. (pcf)	MOISTURE CONTENT (%)	ATTERBERG LIMITS LIQUID LIMIT (%)	ATTERBERG LIMITS PLASTIC LIMIT (%)	ATTERBERG LIMITS PLASTICITY INDEX (%)	FINES CONTENT (%)
0		SILTY CLAY (CL), brown, moist (ARTIFICIAL FILL)									
		FAT CLAY (CH), gray to dark gray, moist, soft consistency, medium stiff, dilatancy slow, less than 5% sand, pocket torvane=0.46tsf at 5 ft (ALLUVIUM) **(TX-CU-P)**	SH			39 48	105 83	93	33	60	
5					0.50						
		FAT CLAY (CH), gray to gray brown, moist to wet, medium stiff, less than 5% sand, some silt **(UC, consolidation)**	CM	3-5-6		61 68	63 54	85	26	59	
			SH			117	15				22
10		SILTY SAND with GRAVEL (SM), blue gray, wet, loose, very fine to coarse sand, rounded gravel up to 1/2 in.									
		LEAN CLAY (CL) to LEAN CLAY with SAND (CL), brown, wet, medium stiff	CM	5-2-4							
			SH								
15		POORLY GRADED SAND with SILT (SP-SM), brown, wet, loose, fine sand									
		SILT (ML), brown, wet, medium stiff, low plasticity, very fine sand less than 10%, rapid dilatancy	CM	3-4-3			29	32	18	14	
		Driller indicated gravel and sand in cutting at 18.5 ft									
20		SILTY SAND (SM) interbedded, brown, wet, medium stiff and medium dense, very fine to coarse sand	SPT	5-6-8							
		SILT with SAND (ML), brown, moist to wet, stiff, low to medium plasticity, very fine sand									
		Driller indicated gravel at 22 ft									
25		POORLY GRADED GRAVEL (GP), brown gray, wet, medium dense, angular gravel up to 3/8 in.	CM	12-17-50							
		SANDY LEAN CLAY with GRAVEL (CL), olive brown, wet, stiff, very fine to medium sand, cobble larger than 3 in. at bottom of sample	SPT	22-31-24							
		POORLY GRADED GRAVEL (GP), gray brown, wet, very dense, subrounded to subangular, up to 3/8 in.									
30		Hole caved to 28 ft, up to 1/2 in. gravel in cuttings, caving of 2-3 ft following drilling advancement to 32 ft									
35											

(Continued Next Page)

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BORING NUMBER B-092+50E

CLIENT SCVWD c/o GEI Consultants

PROJECT NAME Lower Llagas Creek Restoration Project

PROJECT NUMBER 110810

PROJECT LOCATION Between HWY 152 and Bloomfield Ave., Gilroy, CA

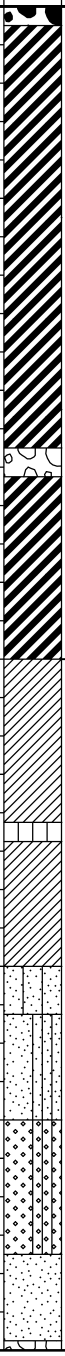
DEPTH (ft)	GRAPHIC LOG	MATERIAL DESCRIPTION	SAMPLE TYPE	BLOW COUNTS (FIELD VALUE)	POCKET PEN. (tsf)	DRY UNIT WT. (pcf)	MOISTURE CONTENT (%)	ATTERBERG LIMITS			FINES CONTENT (%)
								LIQUID LIMIT (%)	PLASTIC LIMIT (%)	PLASTICITY INDEX (%)	
35		POORLY GRADED GRAVEL (GP), brown gray, wet, loose, angular gravel up to 3/8 in.	CM	10-9-10							
		SILT with SAND (ML) to SANDY SILT (ML), brown, wet, stiff, very fine to fine sand, medium to low plasticity									
40		LEAN CLAY with SAND (CL) to LEAN CLAY (CL), brown, moist, very stiff, stiff consistency, very fine to medium sand, very thin silty sand layers at 40.5 ft	CM	11-20-29	2.75	107	23				
45		LEAN CLAY (CL), blue gray, moist, stiff, firm to stiff consistency, medium plasticity, less than 5% sand	CM	7-9-10	1.75						

Bottom of borehole at 48.0 ft. Borehole backfilled with grout.

BORING NUMBER B-092+50W

PAGE 1 OF 2

CLIENT SCVWD c/o GEI Consultants
PROJECT NAME Lower Llagas Creek Restoration Project
PROJECT NUMBER 110810
PROJECT LOCATION Between HWY 152 and Bloomfield Ave., Gilroy, CA
DATE STARTED 1/9/2012 **COMPLETED** 1/9/2012
GROUND ELEVATION 164 ft **HOLE SIZE** 6 in.
DRILLING CONTRACTOR EXPLORATION GEOSERVICES
GROUND WATER LEVELS:
DRILLING METHOD 6-inch HOLLOWSTEM AUGER
▽ **AT TIME OF DRILLING** 26.0 ft / Elev 138.0 ft
LOGGED BY D. BURGER **CHECKED BY**
AT END OF DRILLING ---
NOTES Hammer Type: 140#/30" cabledrop
AFTER DRILLING ---



DEPTH (ft)	MATERIAL DESCRIPTION	SAMPLE TYPE	BLOW COUNTS (FIELD VALUE)	POCKET PEN. (tsf)	DRY UNIT WT. (pcf)	MOISTURE CONTENT (%)	ATTERBERG LIMITS LIQUID LIMIT (%)	ATTERBERG LIMITS PLASTIC LIMIT (%)	ATTERBERG LIMITS PLASTICITY INDEX (%)	FINES CONTENT (%)
0	Approximately 6 in. of gravel (ARTIFICIAL FILL) FAT CLAY (CH), brown, dry to slightly moist (LEVEE FILL)									
	FAT CLAY (CH), dark brown, slightly moist to moist, very stiff, medium to high plasticity **(UC)**	CM	6-9-12	2.50	95	26				
5	FAT CLAY (CH), brown and dark brown, moist, stiff, medium to high plasticity, trace very fine sand, trace organics	SPT	5-8-9							
	FAT CLAY (CH), very dark gray brown to black, moist, hard, less than 5% sand **(UC)**	CM	5-15-15	4.5+	91	28	62	24	38	
10	FAT CLAY (CH), dark olive gray brown, moist, very stiff, grades to black clay at 8.5 ft	SPT	7-10-12							
	FAT CLAY (CH), black, slighty moist, hard, trace gravel POORLY GRADED GRAVEL with SAND (GP), dark gray brown, dry, dense, medium to very coarse sand, gravel up to 1/2 in.	CM	10-12-17	4.10						
15	FAT CLAY (CH), dark gray brown, slightly moist, stiff, medium to high plasticity, increased silt content with depth	SPT	5-6-8							
	FAT CLAY (CH), very dark gray brown to black, moist, firm to soft consistency, stiff, trace light brown sand nodules	CM	6-7-9	1.50						
	LEAN CLAY (CL), dark gray, moist to wet, soft consistency, medium plasticity (ALLUVIUM)									
20	LEAN CLAY (CL) to LEAN CLAY with GRAVEL (CL), dark gray, moist to wet, stiff, rounded gravel up to 1/2 in., very fine sand less than 15%	SH								
	SILT (ML) lens LEAN CLAY (CL), blue gray with brown mottling, moist, stiff, medium to low plasticity, dilatancy slow to rapid **(UC)**	CM	5-6-7	1.70 1.00 1.30	95	29				
25		SH			116	17	18	14	4	45
	▽ SILTY SAND (SM), brown, wet, very fine to fine sand, low to non-plastic **(TX-UU)**			0.10						
	POORLY GRADED SAND with SILT and GRAVEL (SP-SM), light brown, wet, medium dense, very fine to coarse sand, rounded to subrounded gravel up to 1/2 in.	CM	10-14-9							
30	WELL GRADED SAND with SILT and GRAVEL (SW-SM), brown gray, wet, dense, medium to very coarse sand, gravel up to 1/2 in.	CM	10-21-23		121	12				8
35	POORLY GRADED SAND (SP), brown gray, wet, very dense, medium to very coarse sand	SPT	24-40-50							

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CLIENT	SCVWD c/o GEI Consultants	**PROJECT NAME**	Lower Llagas Creek Restoration Project
PROJECT NUMBER	110810	**PROJECT LOCATION**	Between HWY 152 and Bloomfield Ave., Gilroy, CA

DEPTH (ft)	GRAPHIC LOG	MATERIAL DESCRIPTION	SAMPLE TYPE	BLOW COUNTS (FIELD VALUE)	POCKET PEN. (tsf)	DRY UNIT WT. (pcf)	MOISTURE CONTENT (%)	ATTERBERG LIMITS LIQUID LIMIT (%)	ATTERBERG LIMITS PLASTIC LIMIT (%)	ATTERBERG LIMITS PLASTICITY INDEX (%)	FINES CONTENT (%)
35		POORLY GRADED GRAVEL with SAND (GP), brown gray, wet, very dense, subangular gravel up to 3/8 in.									
		Assumed contact based on driller information									
40		LEAN CLAY (CL), light brown, moist, stiff, medium to low plasticity, less than 5% sand	SPT	8-13-12							
45		LEAN CLAY (CL), brown, moist, very stiff, medium plasticity, less than 5% sand	CM	6-11-18	2.25						
50		SILT (ML), brown, moist to wet, stiff, medium to low plasticity, very fine sand less than 10%	CM	9-15-18	1.30						
55		SILT (ML), light olive gray brown, moist, stiff, low plasticity, rapid dilatancy, iron stains	CM	7-9-10	1.70						
60		LEAN CLAY (CL), blue gray, moist, very stiff, medium plasticity	CM	10-15-17	2.90						

Bottom of borehole at 60.5 ft. Borehole backfilled with grout.

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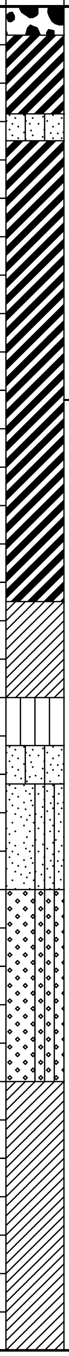
BORING NUMBER B-107+00W

CLIENT SCVWD c/o GEI Consultants
PROJECT NAME Lower Llagas Creek Restoration Project
PROJECT NUMBER 110810
PROJECT LOCATION Between HWY 152 and Bloomfield Ave., Gilroy, CA
DATE STARTED 1/10/2012 **COMPLETED** 1/10/2012
GROUND ELEVATION 166 ft **HOLE SIZE** 6 in.
DRILLING CONTRACTOR EXPLORATION GEOSERVICES
GROUND WATER LEVELS:
DRILLING METHOD 6-inch HOLLOWSTEM AUGER
▽ **AT TIME OF DRILLING** 20.0 ft / Elev 146.0 ft
LOGGED BY D. BURGER **CHECKED BY**
AT END OF DRILLING ---
NOTES Hammer Type: 140#/30" cabledrop
AFTER DRILLING ---



DEPTH (ft)	MATERIAL DESCRIPTION	SAMPLE TYPE	BLOW COUNTS (FIELD VALUE)	POCKET PEN. (tsf)	DRY UNIT WT. (pcf)	MOISTURE CONTENT (%)	ATTERBERG LIMITS			FINES CONTENT (%)
							LIQUID LIMIT (%)	PLASTIC LIMIT (%)	PLASTICITY INDEX (%)	
0	Approximately 9 in. of gravel (ARTIFICIAL FILL)									
	FAT CLAY (CH) to FAT CLAY with GRAVEL (CH), brown to dark brown, dry, hard, angular gravel up to very fine to medium sand (LEVEE FILL)	CM	11-27-19							
	SILTY SAND (SM), light brown, dry, medium dense, very fine to medium sand	SPT	8-9-8							
5	FAT CLAY (CH), very dark brown, slightly moist, stiff, traces rounded fine gravel, trace very fine sand less than 2%									
	FAT CLAY with SAND (CH), brown, dry, hard, very fine to medium sand, trace fine gravel	CM	15-21-26	4.5+	94	25	65	29	36	
	FAT CLAY (CH), dark brown, hard, fine to coarse sand less than 10% **(UC)**	SPT	7-11-13							
	FAT CLAY (CH), very dark brown, slightly moist, very stiff, thin silt lenses, medium to high plasticity, less than 5% coarse material									
10	FAT CLAY (CH), very dark gray, slightly moist, hard, medium to high plasticity	CM	7-14-13	4.50						
	FAT CLAY (CH), very dark gray to black, slightly moist to moist, high plasticity (ALLUVIUM)									
15	FAT CLAY (CH), dark gray, slightly moist, stiff, firm consistency, high plasticity, less than 5% sand, dilatancy none, pocket torvane=0.7tsf at 14 ft **(TX-UU, consolidation)**	SH		1.25	86 85	34 37	63	19	44	
	LEAN CLAY (CL), dark brown to olive brown, moist, stiff to very stiff, medium plasticity, trace sand, pocket torvane=0.9tsf at 16 ft	CM	4-6-11	2.00						
	SILT with SAND (ML), green gray, moist, soft consistency, very fine to fine sand									
20	▽ SILTY SAND (SM), green gray, moist to wet, loose, very fine sand	CM	5-7-16		109	22				33
	POORLY GRADED SAND with SILT (SP-SM), olive brown, wet, medium dense, fine to very coarse sand	SPT	7-10-16							
	POORLY GRADED SAND with SILT and GRAVEL (SP-SM), brown, wet, medium dense, angular to subangular gravel up to 1/2 in., fine to very coarse sand									
25	WELL GRADED SAND with SILT and GRAVEL (SW-SM), gray brown, wet, very dense, angular gravel up to 1 in., fine to very coarse sand	SPT	10-21-45			11				9
30	LEAN CLAY (CL), light brown, moist to wet, hard, medium plasticity, less than 5% sand	CM	8-16-19	4.20	107	22				
35	LEAN CLAY (CL), light brown, wet, very stiff, medium plasticity	CM	13-21-30							

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BORING NUMBER B-107+00W

CAL ENGINEERING & GEOLOGY

CLIENT SCVWD c/o GEI Consultants

PROJECT NAME Lower Llagas Creek Restoration Project

PROJECT NUMBER 110810

PROJECT LOCATION Between HWY 152 and Bloomfield Ave., Gilroy, CA

DEPTH (ft)	GRAPHIC LOG	MATERIAL DESCRIPTION	SAMPLE TYPE	BLOW COUNTS (FIELD VALUE)	POCKET PEN. (tsf)	DRY UNIT WT. (pcf)	MOISTURE CONTENT (%)	ATTERBERG LIMITS			FINES CONTENT (%)
								LIQUID LIMIT (%)	PLASTIC LIMIT (%)	PLASTICITY INDEX (%)	
35	▨										
40	▨	LEAN CLAY (CL), light brown, moist, hard, medium to low plasticity, trace very fine sand	CM	12-24-41							
45	▨	LEAN CLAY (CL), brown, moist, stiff consistency, hard, trace very fine sand, medium plasticity, trace calcite stringers	CM	6-14-20	4.00						
50	▥	SILT with SAND (ML), brown, moist to wet, stiff, very fine sand, medium to low plasticity	CM	9-9-12	1.50						
55	▨	LEAN CLAY (CL), light olive brown, moist to wet, stiff, medium plasticity, less than 5% sand	CM	7-9-11							
60	▨	LEAN CLAY (CL), gray with brown mottling, moist, very stiff, trace very fine sand, medium plasticity	CM	13-20-31	2.25						

Bottom of borehole at 60.5 ft. Borehole backfilled with grout.

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BORING NUMBER B-116+50E

CLIENT SCVWD c/o GEI Consultants
PROJECT NAME Lower Llagas Creek Restoration Project
PROJECT NUMBER 110810
PROJECT LOCATION Between HWY 152 and Bloomfield Ave., Gilroy, CA
DATE STARTED 1/12/2012 **COMPLETED** 1/12/2012
GROUND ELEVATION 169 ft **HOLE SIZE** 6 in.
DRILLING CONTRACTOR EXPLORATION GEOSERVICES
GROUND WATER LEVELS:
DRILLING METHOD 6-inch HOLLOWSTEM AUGER
∇ **AT TIME OF DRILLING** 22.0 ft / Elev 147.0 ft
LOGGED BY D. BURGER **CHECKED BY**
AT END OF DRILLING ---
NOTES Hammer Type: 140#/30" cabledrop
AFTER DRILLING ---

DEPTH (ft)	GRAPHIC LOG	MATERIAL DESCRIPTION	SAMPLE TYPE	BLOW COUNTS (FIELD VALUE)	POCKET PEN. (tsf)	DRY UNIT WT. (pcf)	MOISTURE CONTENT (%)	ATTERBERG LIMITS LIQUID LIMIT (%)	ATTERBERG LIMITS PLASTIC LIMIT (%)	ATTERBERG LIMITS PLASTICITY INDEX (%)	FINES CONTENT (%)
0		FAT CLAY (CH), brown, dry, possible rip-rap at 1 ft (LEVEE FILL)									
		FAT CLAY (CH) to FAT CLAY with SAND (CH), dark brown, dry, hard, less than 10% angular gravel	CM	22-23-19	4.5+						
			SPT	12-14-15							
5		SANDY SILT (ML), light brown, dry, very stiff, very fine to fine sand near 50%, non-plastic									
		SANDY SILT with GRAVEL (ML), gray brown, dry, hard, very fine to medium sand, rounded gravel up to 1/2 in.	CM	11-13-10	4.5+						
		GRAVELLY FAT CLAY with SAND (CH), brown, dry, hard, angular gravel up to 1/4 in., very fine to fine sand	SPT	4-6-8							
		FAT CLAY (CH), black, slightly moist, stiff, trace sand, organic stringers									
10		FAT CLAY (CH), gray, moist, very stiff, medium plasticity, less than 5% sand, dilatancy none, stiff consistency, pocket torvane=0.53tsf at 12 ft (ALLUVIUM) **(TX-UU)**	SH		2.90	91	31	66	23	43	
		LEAN CLAY (CL), dark brown, moist, very stiff, medium plasticity, less than 5% sand	CM	7-9-12	2.75						
15		LEAN CLAY (CL), orange brown, moist, very stiff, medium plasticity, increased sand with depth up to 10% very fine sand between 16.5 and 17 ft, decreased sand content below, bioturbation near bottom of sample	CM	8-11-17	3.00	112	18				
			SPT	9-13-16							
20		LEAN CLAY (CL), orange brown grade to olive gray, moist, hard, medium plasticity **(UC)**	CM	11-15-19	4.20	110	19	35	16	19	
	∇										
25		SANDY SILT with GRAVEL (ML), light olive brown, wet, very stiff	CM	14-25-30	2.70						
		POORLY GRADED SAND with CLAY/SILT and GRAVEL (SP-SM), olive brown, wet, very dense, subangular to subrounded gravel up to 3/8 in., very fine to coarse sand, iron stains									
30		LEAN CLAY (CL), light orange brown, moist to wet, stiff, medium plasticity, dilatancy none, less than 5% sand	CM	9-11-14	1.90 2.00	101	25				
35		LEAN CLAY (CL), brown to light brown, moist to wet, stiff, medium	CM	8-7-11							

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BORING NUMBER B-116+50E

CLIENT SCVWD c/o GEI Consultants

PROJECT NAME Lower Llagas Creek Restoration Project

PROJECT NUMBER 110810

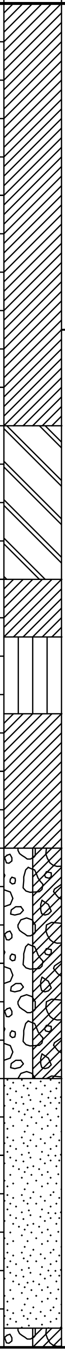
PROJECT LOCATION Between HWY 152 and Bloomfield Ave., Gilroy, CA

DEPTH (ft)	GRAPHIC LOG	MATERIAL DESCRIPTION	SAMPLE TYPE	BLOW COUNTS (FIELD VALUE)	POCKET PEN. (tsf)	DRY UNIT WT. (pcf)	MOISTURE CONTENT (%)	ATTERBERG LIMITS LIQUID LIMIT (%)	ATTERBERG LIMITS PLASTIC LIMIT (%)	ATTERBERG LIMITS PLASTICITY INDEX (%)	FINES CONTENT (%)
35		plasticity, less than 5% sand			1.25						
40		LEAN CLAY (CL), brown, moist, very stiff, medium plasticity, firm consistency, grades to silt at 40.25 ft	CM	9-11-16	2.10						
45		SILT (ML) to SILT with SAND (ML), light olive brown, wet, stiff, very fine to fine sand, low plasticity	CM	7-10-12							
		LEAN CLAY (CL), light brown gray, moist, very stiff, iron stains, medium to low plasticity									
50		SILT (ML) to SILT with SAND (ML), light gray brown, moist to wet, stiff, very fine to medium sand, low plasticity	CM	6-12-15	1.50						
		Driller indicated sands at 53 ft									
55		WELL GRADED SAND (SW), gray brown, wet, very dense, medium to coarse sand, less than 5% fines, up to 1/4 in. subrounded gravel near bottom of sample	SPT	50							
60		POORLY GRADED GRAVEL with SILT and SAND (GP-GM), gray, wet, very dense, fine to very coarse sand, trace to few fines, subrounded to angular gravel up to 1.5+ in.	SPT	35-50							
65		SILT (ML), olive brown, moist, stiff, firm consistency, medium to low plasticity, less than 5% sand	CM	17-23-29	1.7						

Bottom of borehole at 65.5 ft. Borehole backfilled with grout.

BORING NUMBER B-127+00W

CLIENT	SCVWD c/o GEI Consultants	**PROJECT NAME**	Lower Llagas Creek Restoration Project
PROJECT NUMBER	110810	**PROJECT LOCATION**	Between HWY 152 and Bloomfield Ave., Gilroy, CA
DATE STARTED	1/9/2012 **COMPLETED** 1/9/2012	**GROUND ELEVATION**	171 ft **HOLE SIZE** 6 in.
DRILLING CONTRACTOR	EXPLORATION GEOSERVICES	**GROUND WATER LEVELS:**	
DRILLING METHOD	6-inch HOLLOWSTEM AUGER	▽ **AT TIME OF DRILLING**	18.0 ft / Elev 153.0 ft
LOGGED BY	D. BURGER **CHECKED BY**	**AT END OF DRILLING**	---
NOTES	Hammer Type: 140#/30" cabledrop	**AFTER DRILLING**	---



DEPTH (ft)	MATERIAL DESCRIPTION	SAMPLE TYPE	BLOW COUNTS (FIELD VALUE)	POCKET PEN. (tsf)	DRY UNIT WT. (pcf)	MOISTURE CONTENT (%)	ATTERBERG LIMITS: LIQUID LIMIT (%)	ATTERBERG LIMITS: PLASTIC LIMIT (%)	ATTERBERG LIMITS: PLASTICITY INDEX (%)	FINES CONTENT (%)
0	LEAN CLAY (CL) to LEAN CLAY with GRAVEL (CL), dark brown, slightly moist, hard, medium plasticity, angular gravel up to 3/4 in. (LEVEE FILL)	CM	15-19-22	4.5+						
		SPT	11-14-13							
5	LEAN CLAY (CL) to LEAN CLAY with SAND (CL), brown to dark brown, slightly moist, hard, very fine to fine sand, trace gravel **(UC)**	CM	11-9-10	4.5+	102	14	41	18	22	
	Orange plastic in cuttings									
10	LEAN CLAY (CL), brown, moist, very stiff, medium plasticity (ALLUVIUM) **(TX-UU)**	SH		3.40	91	28				
	Thin lens of poorly graded sand, olive brown and moist at 10.75 ft LEAN to FAT CLAY (CL/CH), very dark brown to black, moist, very stiff	CM	8-8-10	2.30						
15	LEAN CLAY (CL), dark brown, moist, black clay in cutting between 11.5 and 14 ft **(TX-UU)**	SH			99	22	40	18	22	
	LEAN CLAY (CL) to LEAN CLAY with SAND (CL), brown, moist, stiff, very fine sand rapid dilatancy, little silt, pocket torvane=0.55tsf at 16 ft			1.75						
	SILT with SAND (ML), brown, moist to wet, firm, very fine to medium sand ▽	CM	5-5-6		102	26				72
20	LEAN CLAY (CL), brown, moist to wet, medium stiff, medium plasticity, less than 5% sand	CM	5-6-9	0.90	93	31				
25	POORLY GRADED GRAVEL with CLAY and SAND (GP-GC), brown gray, wet, dense, subrounded to subangular gravel up to 1 in., very fine to very coarse sand, trace iron stains	CM	14-19-24		133	11				13
30	POORLY GRADED SAND (SP), gray to brown gray, wet, very dense, medium to very coarse sand, subangular to subrounded gravel up to 3/8 in.	CM	10-35-50			17				5
35	POORLY GRADED SAND (SP), gray, wet, very dense, fine to very coarse sand	SPT	30-35-33							

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BORING NUMBER B-127+00W

CLIENT SCVWD c/o GEI Consultants

PROJECT NAME Lower Llagas Creek Restoration Project

PROJECT NUMBER 110810

PROJECT LOCATION Between HWY 152 and Bloomfield Ave., Gilroy, CA

DEPTH (ft)	GRAPHIC LOG	MATERIAL DESCRIPTION	SAMPLE TYPE	BLOW COUNTS (FIELD VALUE)	POCKET PEN. (tsf)	DRY UNIT WT. (pcf)	MOISTURE CONTENT (%)	ATTERBERG LIMITS			FINES CONTENT (%)
								LIQUID LIMIT (%)	PLASTIC LIMIT (%)	PLASTICITY INDEX (%)	
35		POORLY GRADED GRAVEL with CLAY and SAND (GP-GC), brown gray, wet, very dense, subangular gravel up to 3/8 in. grades to poorly graded gravel with silt and sand (GP-GM), gray brown, very fine to very coarse sand, trace iron stains, subrounded gravel up to 1 in.									
40		LEAN CLAY (CL), light brown, moist to wet, hard, medium plasticity, iron stains, less than 5% sand	SPT	10-16-21							
		LEAN CLAY (CL), olive brown, moist, firm consistency, medium plasticity	CM	4-8-11							
45		SILT (ML), brown, wet, stiff, low plasticity, less than 10% very fine sand	CM	9-12-15	1.25						
		ELASTIC SILT (MH), brown, moist to wet, stiff, less than 5% sand									
		Driller indicated sand at 47.5 ft									
50		WELL GRADED SAND (SW), olive brown, wet, dense, fine to medium sand	SPT	14-50							
		POORLY GRADED GRAVEL with SAND (GP), brown gray, wet, very dense, subrounded gravel up to 3/4 in.									
55		POORLY GRADED GRAVEL with SAND (GP), brown gray, wet, very dense, medium to very coarse sand, rounded to subrounded gravel up to 3/4 in.	SPT	25-50							
60		LEAN CLAY (CL), light brown, moist to wet, very stiff, trace very fine sand, medium plasticity, thin lenses of silt	SPT	11-11-16							

Bottom of borehole at 60.5 ft. Borehole backfilled with grout.

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BORING NUMBER B-132+00W

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CLIENT SCVWD c/o GEI Consultants

PROJECT NAME Lower Llagas Creek Restoration Project

PROJECT NUMBER 110810

PROJECT LOCATION Between HWY 152 and Bloomfield Ave., Gilroy, CA

DATE STARTED 1/6/2012 **COMPLETED** 1/6/2012

GROUND ELEVATION 172 ft **HOLE SIZE** 6 in.

DRILLING CONTRACTOR EXPLORATION GEOSERVICES

GROUND WATER LEVELS:

DRILLING METHOD 6-inch HOLLOWSTEM AUGER

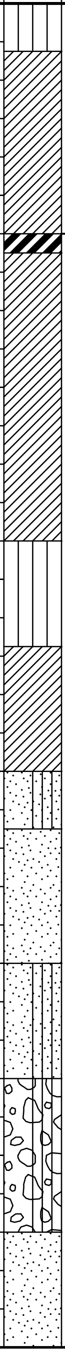
∇ **AT TIME OF DRILLING** 19.5 ft / Elev 152.5 ft

LOGGED BY D. BURGER **CHECKED BY**

AT END OF DRILLING ---

NOTES Hammer Type: 140#/30" cabledrop

AFTER DRILLING ---



DEPTH (ft)	MATERIAL DESCRIPTION	SAMPLE TYPE	BLOW COUNTS (FIELD VALUE)	POCKET PEN. (tsf)	DRY UNIT WT. (pcf)	MOISTURE CONTENT (%)	ATTERBERG LIMITS LIQUID LIMIT (%)	ATTERBERG LIMITS PLASTIC LIMIT (%)	ATTERBERG LIMITS PLASTICITY INDEX (%)	FINES CONTENT (%)
0	CLAYEY SILT with SAND (ML), brown, dry, trace gravel, darker brown color at 8 in. (LEVEE FILL)									
	LEAN CLAY (CL), dark brown, dry to slightly moist, hard, organic stringers, trace very fine sand	CM	19-50							
	LEAN CLAY (CL) and LEAN CLAY with SAND (CL), brown, slightly moist, hard, trace gravel up to 3/4 in., very fine to fine sand	SPT	17-25-26							
5	LEAN CLAY (CL) to LEAN CLAY with SAND (CL), brown, moist, stiff, very fine sand, medium plasticity	CM	7-8-14	4.00	73	37	71	28	43	
	FAT CLAY (CH), black, moist, very stiff, high plasticity, trace sand (ALLUVIUM) **(UC)** LEAN CLAY (CL), brown gray, moist, stiff, iron stains, medium plasticity	SPT	4-7-7							
10	LEAN CLAY (CL), gray brown, moist, very stiff consistency, hard, iron stains, trace very fine sand, medium plasticity	CM	9-16-19	4.5+	96	25				
	LEAN CLAY (CL), light orange brown with color change at 11.75 ft, slightly moist, very stiff, trace sand in nodules, iron stains, medium to low plasticity	SPT	6-7-11							
15	SILT with SAND (ML) to SANDY SILT (ML), orange brown, moist, very stiff, iron stains SANDY SILT (ML), orange brown, slightly moist, very stiff, very fine to fine sand	CM	8-13-16	3.10	99	18				54
	LEAN CLAY with SAND (CL) to LEAN CLAY (CL), brown, moist, medium stiff, low plasticity, very fine to medium sand in lenses and nodules ∇	SPT	5-6-8							
20	POORLY GRADED SAND with SILT (SP-SM), light olive gray brown, wet, loose, fine to very coarse sand	SH								
		CM	4-5-6							
25	POORLY GRADED SAND (SP), brown gray, wet, medium dense, fine to coarse sand, decreasing fines content with depth	CM	8-18-35		114	14				7
	POORLY GRADED SAND with SILT and GRAVEL (SP-SM), brown gray, wet, dense, rounded gravel up to 3/4 in., fine to very coarse sand									
30	POORLY GRADED GRAVEL with SILT and SAND (GP-GM), gray brown, wet, very dense, fine to very coarse sand, subangular to subrounded gravel up to 3/4 in.	SPT	13-34-30							
35	POORLY GRADED SAND with GRAVEL (SP), gray to brown gray, wet,	SPT	20-50			17				2

(Continued Next Page)

BORING NUMBER B-132+00W

CLIENT SCVWD c/o GEI Consultants
PROJECT NAME Lower Llagas Creek Restoration Project
PROJECT NUMBER 110810
PROJECT LOCATION Between HWY 152 and Bloomfield Ave., Gilroy, CA

DEPTH (ft)	GRAPHIC LOG	MATERIAL DESCRIPTION	SAMPLE TYPE	BLOW COUNTS (FIELD VALUE)	POCKET PEN. (tsf)	DRY UNIT WT. (pcf)	MOISTURE CONTENT (%)	ATTERBERG LIMITS			FINES CONTENT (%)
								LIQUID LIMIT (%)	PLASTIC LIMIT (%)	PLASTICITY INDEX (%)	
35		very dense, gravel increases in size toward bottom of sample to 1/2 in., medium to very coarse sand									
		POORLY GRADED SAND (SP), gray, wet, dense, fine to coarse sand	SPT	20-41-24							
40		POORLY GRADED GRAVEL with SILT and SAND (GP-GM), brown gray, wet, very dense, subangular to subrounded gravel up to 3/4 in., fine to very coarse sand									
		Driller indicated change at 42 ft SILTY SAND (SM), light brown, wet, medium dense to loose, very fine to fine sand	SPT	7-9-11							
45		LEAN CLAY (CL), light brown, wet, stiff, medium plasticity, decreasing very fine sand with depth to less than 5% sand									

Bottom of borehole at 45.5 ft. Borehole backfilled with grout.

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BORING NUMBER B-132+50E

PAGE 1 OF 2

CLIENT SCVWD c/o GEI Consultants

PROJECT NAME Lower Llagas Creek Restoration Project

PROJECT NUMBER 110810

PROJECT LOCATION Between HWY 152 and Bloomfield Ave., Gilroy, CA

DATE STARTED 1/12/2012 **COMPLETED** 1/12/2012

GROUND ELEVATION 175 ft **HOLE SIZE** 6 in.

DRILLING CONTRACTOR EXPLORATION GEOSERVICES

GROUND WATER LEVELS:

DRILLING METHOD 6-inch HOLLOWSTEM AUGER

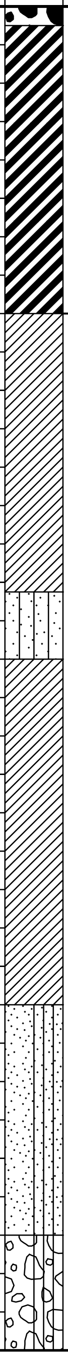
∇ **AT TIME OF DRILLING** 25.5 ft / Elev 149.5 ft

LOGGED BY D. BURGER **CHECKED BY**

AT END OF DRILLING ---

NOTES Hammer Type: 140#/30" cabledrop

AFTER DRILLING ---



DEPTH (ft)	MATERIAL DESCRIPTION	SAMPLE TYPE	BLOW COUNTS (FIELD VALUE)	POCKET PEN. (tsf)	DRY UNIT WT. (pcf)	MOISTURE CONTENT (%)	ATTERBERG LIMITS LIQUID LIMIT (%)	ATTERBERG LIMITS PLASTIC LIMIT (%)	ATTERBERG LIMITS PLASTICITY INDEX (%)	FINES CONTENT (%)
0	Approximately 6 in. of gravel (ARTIFICIAL FILL)									
	FAT CLAY (CH) to FAT CLAY with SAND (CH), very dark brown, dry to slightly moist, hard, isolated gravel (LEVEE FILL)	CM	19-15-17	4.5+	107	20				
		SPT	7-11-11							
5	FAT CLAY with SAND (CH), brown, slightly moist, very stiff, less than 10% fine gravel, very fine to coarse sand									
	FAT CLAY (CH), gray brown to red gray brown, moist, very stiff, stiff to firm consistency, medium to high plasticity, less than 10% sand **(UC)**	CM	5-7-8	2.40	100	26				
	LEAN to FAT CLAY (CL/CH), very dark brown, moist, stiff, medium to high plasticity, less than 5% sand (ALLUVIUM)	SPT	5-7-8							
10	LEAN CLAY (CL), brown gray, slightly moist, very stiff, medium plasticity, less than 5% sand **(TX-UU)**	SH		4.00	101	24	49	19	31	
	LEAN CLAY (CL), gray brown to brown gray, slightly moist, very stiff, medium plasticity, less than 5% sand, trace iron stains	CM	9-14-16	3.40						
15										
	SANDY SILT (ML), light red brown, moist stiff, very fine to fine sand, iron stains	CM	5-6-9	1.30	102	23				63
20	LEAN CLAY (CL), brown, moist, medium stiff, medium plasticity, slow dilatancy, little silt, trace iron stains and sand **(UC)**	CM	3-4-6	0.90	103	24				
25	LEAN CLAY with SAND (CL) grades to LEAN CLAY (CL), moist, hard, gravel up to 1/2 in. angular, very fine to coarse sand ∇	CM	28-25-40	4.5+						
30	POORLY GRADED SAND with SILT and GRAVEL (SP-SM), brown gray, wet, very dense, medium to very coarse sand, rounded gravel up to 3/8 in.	CM	12-23-50			18				9
35	POORLY GRADED GRAVEL with SILT and SAND (GP-GM), gray	SPT	17-24-30							

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CAL ENGINEERING & GEOLOGY

BORING NUMBER B-132+50E

CLIENT SCVWD c/o GEI Consultants

PROJECT NAME Lower Llagas Creek Restoration Project

PROJECT NUMBER 110810

PROJECT LOCATION Between HWY 152 and Bloomfield Ave., Gilroy, CA

DEPTH (ft)	GRAPHIC LOG	MATERIAL DESCRIPTION	SAMPLE TYPE	BLOW COUNTS (FIELD VALUE)	POCKET PEN. (tsf)	DRY UNIT WT. (pcf)	MOISTURE CONTENT (%)	ATTERBERG LIMITS LIQUID LIMIT (%)	ATTERBERG LIMITS PLASTIC LIMIT (%)	ATTERBERG LIMITS PLASTICITY INDEX (%)	FINES CONTENT (%)
35		brown, wet, very dense, medium to very coarse sand, subangular gravel up to 3/4 in.									
40		WELL GRADED SAND (SW), dark brown gray, wet, medium dense, fine to very coarse sand, fine angular gravel	SPT	16-10-14			15				4
		Driller indicated change at 41 ft									
45		LEAN CLAY (CL), brown, moist, stiff, firm consistency, medium plasticity, slow dilatancy	CM	5-6-8	1.20						

Bottom of borehole at 45.5 ft. Borehole backfilled with grout.

BORING NUMBER B-141+00W

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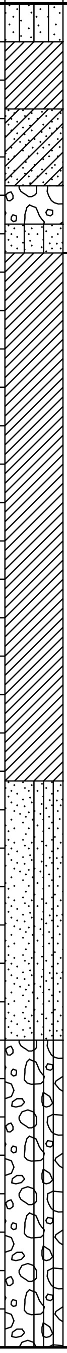
CLIENT SCVWD c/o GEI Consultants
PROJECT NAME Lower Llagas Creek Restoration Project
PROJECT NUMBER 110810
PROJECT LOCATION Between HWY 152 and Bloomfield Ave., Gilroy, CA
DATE STARTED 1/6/2012 **COMPLETED** 1/6/2012
GROUND ELEVATION 173 ft **HOLE SIZE** 6 in.
DRILLING CONTRACTOR EXPLORATION GEOSERVICES
GROUND WATER LEVELS:
DRILLING METHOD 6-inch HOLLOWSTEM AUGER
▽ **AT TIME OF DRILLING** 22.0 ft / Elev 151.0 ft
LOGGED BY D. BURGER **CHECKED BY**
AT END OF DRILLING ---
NOTES Hammer Type: 140#/30" cabledrop
AFTER DRILLING ---



DEPTH (ft)	MATERIAL DESCRIPTION	SAMPLE TYPE	BLOW COUNTS (FIELD VALUE)	POCKET PEN. (tsf)	DRY UNIT WT. (pcf)	MOISTURE CONTENT (%)	ATTERBERG LIMITS LIQUID LIMIT (%)	ATTERBERG LIMITS PLASTIC LIMIT (%)	ATTERBERG LIMITS PLASTICITY INDEX (%)	FINES CONTENT (%)
0	SANDY SILT (ML) to SILTY SAND (SM), brown, dry to slightly moist (LEVEE FILL)									
	SANDY LEAN CLAY (CL), brown, slightly moist, stiff, very fine sand SANDY LEAN CLAY (CL), dark brown, slightly moist, stiff	CM	9-16-14		112	11				54
	CLAYEY SAND with GRAVEL (SC), brown, slightly moist, medium dense, very fine to medium sand, subrounded gravel up to 3/4 in.	SPT	8-9-9			6				20
5	POORLY GRADED GRAVEL with SAND (GP), brown gray, dry, loose, rounded to angular gravel, very fine to coarse sand	CM	5-6-10			6				18
	SILTY SAND (SM), orange brown, slightly moist, stiff, very fine sand									
	LEAN to FAT CLAY (CL/CH), very dark brown to black, moist, stiff, medium to high plasticity, less than 5% sand (ALLUVIUM)	SPT	3-5-7							
10	LEAN CLAY (CL), olive gray brown, moist, very stiff, medium plasticity, trace sand nodules, trace iron stains **(UC)**	CM	8-12-16	3.30	101 100	24 24	47	19	28	
	LEAN CLAY (CL), light brown, moist, medium stiff, less than 10% very fine sand, slow dilatancy, medium plasticity	SPT	4-4-5							
15	LEAN CLAY with SAND (CL) to LEAN CLAY (CL), brown, moist, stiff, firm consistency, very fine sand, decreased sand content with depth, medium to low plasticity	CM	4-5-6	1.50						
	SANDY LEAN CLAY (CL), moist to wet, soft consistency, medium stiff, very fine to medium sand, medium plasticity, little silt	SH		0.80						
20	Lean clay grades to 1/2 in. angular gravel in sample recovered	CM	8-11-14							
	▽									
25	POORLY GRADED SAND with SILT and GRAVEL (SP-SM), gray brown, wet, dense, angular to subangular gravel up to 1 in., fine to very coarse sand	SPT	9-18-27			13				11
30	POORLY GRADED GRAVEL with SILT and SAND (GP-GM), brown gray, wet, very dense, angular to subangular gravel larger than 1 in., very coarse sand	CM	40-50		133	10				7
35	POORLY GRADED GRAVEL with SILT and SAND (GP-GM), brown	SPT	21-30-33							

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BORING NUMBER B-141+00W

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CLIENT SCVWD c/o GEI Consultants

PROJECT NAME Lower Llagas Creek Restoration Project

PROJECT NUMBER 110810

PROJECT LOCATION Between HWY 152 and Bloomfield Ave., Gilroy, CA

DEPTH (ft)	GRAPHIC LOG	MATERIAL DESCRIPTION	SAMPLE TYPE	BLOW COUNTS (FIELD VALUE)	POCKET PEN. (tsf)	DRY UNIT WT. (pcf)	MOISTURE CONTENT (%)	ATTERBERG LIMITS LIQUID LIMIT (%)	ATTERBERG LIMITS PLASTIC LIMIT (%)	ATTERBERG LIMITS PLASTICITY INDEX (%)	FINES CONTENT (%)
35		gray, wet, dense, medium to very coarse sand, rounded to subrounded gravel up to 1/2 in.									
		POORLY GRADED SAND with CLAY and GRAVEL (SP-SC), dark gray brown, wet, very dense, very dark gray clay lens, gravel up 1/4 in. at bottom of sample									
40		POORLY GRADED SAND (SP), brown gray, wet, medium dense, fine to very course sand, trace fines	SPT	13-14-27							
		Driller indicated change at 41 ft									
45		LEAN CLAY (CL), light olive gray brown, moist, stiff, firm to stiff consistency, iron stains, medium plasticity, dilatancy slow	CM	7-11-15	1.80						

Bottom of borehole at 45.5 ft. Borehole backfilled with grout.

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BORING NUMBER B-148+00E

CLIENT SCVWD c/o GEI Consultants
PROJECT NAME Lower Llagas Creek Restoration Project
PROJECT NUMBER 110810
PROJECT LOCATION Between HWY 152 and Bloomfield Ave., Gilroy, CA
DATE STARTED 1/5/2012 **COMPLETED** 1/5/2012
GROUND ELEVATION 175 ft **HOLE SIZE** 6 in.
DRILLING CONTRACTOR EXPLORATION GEOSERVICES
GROUND WATER LEVELS:
DRILLING METHOD ROTARY WASH
AT TIME OF DRILLING --- Groundwater not determined
LOGGED BY D. BURGER **CHECKED BY**
AT END OF DRILLING ---
NOTES Hammer Type: 140#/30" cabledrop
AFTER DRILLING ---

DEPTH (ft)	MATERIAL DESCRIPTION	SAMPLE TYPE	BLOW COUNTS (FIELD VALUE)	POCKET PEN. (tsf)	DRY UNIT WT. (pcf)	MOISTURE CONTENT (%)	ATTERBERG LIMITS LIQUID LIMIT (%)	ATTERBERG LIMITS PLASTIC LIMIT (%)	ATTERBERG LIMITS PLASTICITY INDEX (%)	FINES CONTENT (%)
0	SANDY SILT with GRAVEL (ML), brown, dry, hard, very fine to medium sand, gravel up to 3/8 in. (ARTIFICIAL FILL)	CM	50							
	SANDY SILT (ML), brown, dry, stiff, very fine to medium sand	SPT	45-13-13			14				60
5	FAT CLAY (CH), brown, moist, stiff consistency, very stiff, high plasticity, iron stains (ALLUVIUM) **(UC)**	CM	8-11-13	3.00	86	33	62	28	34	
	FAT CLAY (CH), very dark gray brown to black, moist, very stiff, medium to high plasticity	SPT	5-6-10							
10	LEAN CLAY (CL), gray brown, moist, very stiff to stiff consistency, very stiff, medium to low plasticity, iron stains	CM	9-14-18	2.60	96	27				
	LEAN CLAY (CL), gray to brown gray, moist, very stiff, medium plasticity, iron stains on fracture surfaces	SPT	7-12-15							
15	LEAN CLAY (CL) to LEAN CLAY with SAND (CL), brown, moist to wet, stiff to very stiff consistency, very stiff, very fine to medium sand, trace angular to sub angular gravel up to 1/2 in.	CM	9-13-13							
	LEAN CLAY (CL), brown to gray brown, moist to wet, soft, soft consistency, medium plasticity, dilatancy slow to none, less than 5% sand, pocket torvane=0.4tsft at 20 ft **(TX-UU)**	SH		0.25	92	31	45	19	26	
20	LEAN CLAY (CL), brown, moist to wet, stiff, minor iron stains, trace very fine sand in pockets	CM	0-0-7	1.50						
25	SILTY SAND (SM), light gray brown, wet, loose, very fine to medium sand	CM	7-17-30							
	LEAN CLAY (CL) to LEAN CLAY with SAND (CL), brown, wet, stiff									
	POORLY GRADED SAND with GRAVEL (SP), brown to gray brown, wet, dense, medium to very coarse sand, angular gravel up to 1/4 in.									
	Driller indicated increased gravel in cuttings at 29 ft									
30	POORLY GRADED GRAVEL with SILT and SAND (GP-GM)	SPT	33-31-35			10				8
	POORLY GRADED SAND with SILT and GRAVEL (SP-SM), brown gray, wet, very dense, medium to very coarse sand, rounded to subrounded gravel up to 1/2 in.									
35										

(Continued Next Page)

CLIENT SCVWD c/o GEI Consultants

PROJECT NAME Lower Llagas Creek Restoration Project

PROJECT NUMBER 110810

PROJECT LOCATION Between HWY 152 and Bloomfield Ave., Gilroy, CA

DEPTH (ft)	GRAPHIC LOG	MATERIAL DESCRIPTION	SAMPLE TYPE	BLOW COUNTS (FIELD VALUE)	POCKET PEN. (tsf)	DRY UNIT WT. (pcf)	MOISTURE CONTENT (%)	ATTERBERG LIMITS LIQUID LIMIT (%)	ATTERBERG LIMITS PLASTIC LIMIT (%)	ATTERBERG LIMITS PLASTICITY INDEX (%)	FINES CONTENT (%)
35		Near loss of circulation between 32 and 40 ft, driller indicated gravel and cobbles, hole caved in due to coarse material below 32 ft									
40											

Bottom of borehole at 40.0 ft. Borehole backfilled with grout.

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BORING NUMBER B-166+50E

CLIENT SCVWD c/o GEI Consultants
PROJECT NAME Lower Llagas Creek Restoration Project
PROJECT NUMBER 110810
PROJECT LOCATION Between HWY 152 and Bloomfield Ave., Gilroy, CA
DATE STARTED 1/5/2012 **COMPLETED** 1/5/2012
GROUND ELEVATION 182 ft **HOLE SIZE** 6 in.
DRILLING CONTRACTOR EXPLORATION GEOSERVICES
GROUND WATER LEVELS:
DRILLING METHOD 6-inch HOLLOWSTEM AUGER
∇ **AT TIME OF DRILLING** 25.0 ft / Elev 157.0 ft
LOGGED BY D. BURGER **CHECKED BY**
AT END OF DRILLING ---
NOTES Hammer Type: 140#/30" cabledrop
AFTER DRILLING ---

DEPTH (ft)	GRAPHIC LOG	MATERIAL DESCRIPTION	SAMPLE TYPE	BLOW COUNTS (FIELD VALUE)	POCKET PEN. (tsf)	DRY UNIT WT. (pcf)	MOISTURE CONTENT (%)	ATTERBERG LIMITS LIQUID LIMIT (%)	ATTERBERG LIMITS PLASTIC LIMIT (%)	ATTERBERG LIMITS PLASTICITY INDEX (%)	FINES CONTENT (%)
0		SILT (ML), brown dry, trace gravel (ARTIFICIAL FILL)									
		SILT with SAND and GRAVEL (ML) grades to SANDY SILT (ML), brown, moist, very stiff, gravel up to 3/4 in., clay stringers	CM	14-21-19		102	12				57
		LEAN CLAY (CL) to LEAN CLAY with SAND (CL), brown, moist, stiff, very fine sand between 10 and 15%, medium to low plasticity, dilatancy slow to rapid, little silt (ALLUVIUM)	SPT	7-7-6							
5			CM	6-3-5	2.75						
		SILT (ML), brown, slightly moist, very stiff, firm consistency, very fine sand less than 10%, low plasticity SILTY SAND (SM), brown, slightly moist, loose, very fine fine sand, grades to silty sand	SPT	3-4-6			14				42
10		LEAN CLAY (CL) to LEAN CLAY with SAND (CL), brown, gray, slightly moist, hard, very fine sand, iron stains, medium to low plasticity, little silt	SH		4.5+						
		LEAN CLAY (CL), dark brown grades to very dark brown/black, moist, very stiff, medium plasticity, sand nodules near bottom of sample	CM	12-14-16	3.75	88	25				
15		LEAN CLAY with SAND lenses (CL), dark brown, moist, very stiff, medium plasticity	SPT	7-9-10							
		SANDY SILT (ML), olive brown, moist, stiff, very fine to coarse sand									
		SILTY SAND (SM), olive brown, moist, loose	CM	8-7-7							
		LEAN CLAY (CL), olive brown, moist, firm to stiff consistency									
20		LEAN CLAY (CL), brown to dark brown, moist, hard, trace very fine sand, iron stains	CM	8-13-18	4.10						
25		∇ Driller indicated sand and gravel at 25 ft, groundwater at 25 ft while drilling POORLY GRADED SAND with SILT and GRAVEL (SP-SM), brown, wet, medium dense, fine to very coarse sand, subangular to subrounded gravel up to 1 in.	SPT	7-10-13							
		Gravel while drilling at 29 ft									
30		POORLY GRADED GRAVEL with SILT and SAND (GP-GM), brown to gray brown, wet, dense, subrounded gravel larger than 1.5 in., fine to coarse sand	SPT	12-28-34							
35											

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BORING NUMBER B-166+50E

CLIENT SCVWD c/o GEI Consultants

PROJECT NAME Lower Llagas Creek Restoration Project

PROJECT NUMBER 110810

PROJECT LOCATION Between HWY 152 and Bloomfield Ave., Gilroy, CA

DEPTH (ft)	GRAPHIC LOG	MATERIAL DESCRIPTION	SAMPLE TYPE	BLOW COUNTS (FIELD VALUE)	POCKET PEN. (tsf)	DRY UNIT WT. (pcf)	MOISTURE CONTENT (%)	ATTERBERG LIMITS LIQUID LIMIT (%)	ATTERBERG LIMITS PLASTIC LIMIT (%)	ATTERBERG LIMITS PLASTICITY INDEX (%)	FINES CONTENT (%)
35		WELL GRADED SAND with SILT and GRAVEL (SW-SM), dark gray brown, wet, dense	SPT	14-23-26			13				6
		POORLY GRADED GRAVEL with SAND (GP), brown gray, wet, dense, fine to very coarse sand, subrounded to subangular gravel up to 1/2 in.									
40		POORLY GRADED SAND with GRAVEL (SP), brown gray, wet, very dense, fine sand grades to coarse sand	SPT	14-30-50							
		POORLY GRADED GRAVEL with SAND (GP), rounded gravel up 1/2 in.									
45		POORLY GRADED SAND (SP), gray brown, wet, very dense, fine to very coarse sand	SPT	12-25-40							
50		No recovery of sample due to gravel/cobble larger than sampler blocking tip	SPT	12-14-38							

Bottom of borehole at 51.5 ft. Borehole backfilled with grout.

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BORING NUMBER B-173+50W

CLIENT SCVWD c/o GEI Consultants
PROJECT NAME Lower Llagas Creek Restoration Project
PROJECT NUMBER 110810
PROJECT LOCATION Between HWY 152 and Bloomfield Ave., Gilroy, CA
DATE STARTED 1/13/2012 **COMPLETED** 1/13/2012
GROUND ELEVATION 185 ft **HOLE SIZE** 6 in.
DRILLING CONTRACTOR EXPLORATION GEOSERVICES
GROUND WATER LEVELS:
DRILLING METHOD 6-inch HOLLOWSTEM AUGER
▽ **AT TIME OF DRILLING** 24.5 ft / Elev 160.5 ft
LOGGED BY D. BURGER **CHECKED BY**
AT END OF DRILLING ---
NOTES Hammer Type: 140#/30" cabledrop
AFTER DRILLING ---

DEPTH (ft)	GRAPHIC LOG	MATERIAL DESCRIPTION	SAMPLE TYPE	BLOW COUNTS (FIELD VALUE)	POCKET PEN. (tsf)	DRY UNIT WT. (pcf)	MOISTURE CONTENT (%)	ATTERBERG LIMITS: LIQUID LIMIT (%)	ATTERBERG LIMITS: PLASTIC LIMIT (%)	ATTERBERG LIMITS: PLASTICITY INDEX (%)	FINES CONTENT (%)
0											
		LEAN CLAY (CL) to LEAN CLAY with GRAVEL (CL), very dark brown, dry, hard, very fine to fine sand less than 10%, rounded gravel up 1/4 in. (ARTIFICIAL FILL)	CM	13-26-27	4.5+						
			SPT	14-10-12							
		SANDY SILT (ML) to SILT with SAND (ML), brown, dry, very stiff, very fine to fine sand (ALLUVIUM)									
5		SILTY SAND (SM), brown, dry, loose, very fine to fine sand	CM	4-11-11		86	9				20
		SANDY LEAN CLAY (CL), dark brown, dry to slightly moist, medium stiff, very fine to fine sand, low plasticity, little silt	SPT	4-4-4							
10		LEAN CLAY (CL), dark brown to gray brown, slightly moist, very stiff, medium plasticity, less than 5% sand, firm to stiff consistency, sandy silt layer between 12 and 12.5 ft	CM	6-11-14	3.50						
		LEAN CLAY (CL), brown, moist, stiff, medium plasticity, dilatancy slow, less than 5% sand	SPT	5-4-11							
15		LEAN CLAY (CL), black, moist, very stiff, less than 10% sand, trace gravel			2.50						
		LEAN CLAY with SAND (CL), light olive brown, moist, very stiff to hard, very fine to medium sand with trace gravel	CM	5-7-11	4.00	105	20				
		LEAN CLAY (CL), brown gray, moist, stiff, stiff consistency, medium plasticity, less than 5% sand, trace iron stains, pocket torvane=1.1tsf at 19 ft	SH		2.00						
20		LEAN CLAY (CL), brown gray, moist, very stiff, medium plasticity, trace sand, trace iron stains	CM	5-9-15	2.50						
		LEAN CLAY (CL) to LEAN CLAY with SAND (CL), brown, moist, stiff, fine to medium sand									
25	▽	POORLY GRADED SAND with GRAVEL (SP), brown, moist to wet, very dense, fine to very coarse sand, gravel larger than sampler at 25 ft	CM	12-26-29		118	13				11
30		POORLY GRADED SAND with GRAVEL (SP), brown gray, wet, medium dense, medium to very coarse sand, angular gravel up to 3/8 in.	SPT	10-8-6							
		SILTY SAND with GRAVEL (SM), light brown, wet, medium dense, angular gravel up to 1 in., very fine to coarse sand									
35		WELL GRADED SAND with SILT and GRAVEL (SW-SM), wet, brown	SPT	10-25-30			13				5

(Continued Next Page)

CE&G
CAL ENGINEERING & GEOLOGY

BORING NUMBER B-173+50W

CLIENT SCVWD c/o GEI Consultants

PROJECT NAME Lower Llagas Creek Restoration Project

PROJECT NUMBER 110810

PROJECT LOCATION Between HWY 152 and Bloomfield Ave., Gilroy, CA

DEPTH (ft)	GRAPHIC LOG	MATERIAL DESCRIPTION	SAMPLE TYPE	BLOW COUNTS (FIELD VALUE)	POCKET PEN. (tsf)	DRY UNIT WT. (pcf)	MOISTURE CONTENT (%)	ATTERBERG LIMITS LIQUID LIMIT (%)	ATTERBERG LIMITS PLASTIC LIMIT (%)	ATTERBERG LIMITS PLASTICITY INDEX (%)	FINES CONTENT (%)
35		gray, very dense, medium to very coarse sand, and gular gravel up to 1 in.									
40		POORLY GRADED SAND with SILT and GRAVEL (SP-SM), brown, gray, wet, very dense, medium to very coarse sand, angular to subangular gravel up to 1 in.	SPT	13-28-50							
45		SILTY SAND (SM), gray, wet, dense	SPT	13-11-15							
50		LEAN CLAY (CL), light brown, moist, stiff, medium plasticity, trace iron stains, dilatancy slow, trace sand	CM	7-12-16	1.00						

Bottom of borehole at 50.5 ft. Borehole backfilled with grout.

CALIFORNIA PUSH
TECHNOLOGIES
INCORPORATED

California Push Technologies Inc.
104 Constitution Drive Suite 2
Menlo Park CA 94025
(C-57 License #884827)

office: 650 854 0300
fax: 650 854 0301

www.cptinc.com

Cone penetration testing and soil sampling methods description.

Rig Description

Our services are based on the state-of-the-art, Geoprobe Model 6625CPT rig, a limited-access, self-anchoring, 20-ton push capacity, track-mounted push platform for dedicated Geotechnical CPT applications with the unique and valuable added ability to quickly perform intermittent or continuous soil sampling.

Weight = ~ 9,500 pounds
Surface load = ~ 4.5 psi
Push capacity = ~ 20 tons; self-anchoring achieved using 10- or 15-inch diameter helical soil anchors driven 4- to 10-feet into the soil
Sampling hammer percussion rate = 32 Hz & 20,000 lbs force/blow
Length = ~ 12 feet; Width = ~ 7 feet
Height (folded) = 7 feet; Height (unfolded) = 14 feet

CPT Description

Our Geoprobe 6625CPT incorporates the Swedish-made Geotech AB Cone Penetration Testing tools which meet the ASTM D-5778 Standard Test Method for Performing Electronic Friction Cone and Piezocone Penetration Testing of Soils. Cones have 10 cm^2 tips and 150 cm^2 friction sleeves, and include a porous filter and pressure sensor located in the u_2 position directly behind the cone. The cone and porous filter are saturated under vacuum with glycerin to promote rapid equilibration with in-situ pore pressures. Cones are advanced at the ASTM standard rate of 2 cm/second. Baseline readings are performed both before and after each push to check for load cell drift. The cone measures bearing (max load = 100 MPa ~ 1044 TSF), friction sleeve (max load = 1.0 MPa ~ 10.4 TSF), and dynamic pore pressure (max load = 2.5 MPa ~ 363 psi) at 2 cm or 4 cm intervals (client's choice) and this data is plotted in real-time and recorded on a laptop computer adjacent to the push platform. Holes are grouted upon completion of each push, or at the end of each day, as site conditions and regulations warrant.

The basic equation to determine the depth to the free water surface from the pore pressure dissipation test is;

Depth to phreatic surface = [Dissipation depth] – [equilibrium pore pressure / unit weight of H2O x unit conversation factor]

...where;

1) Surface elevation is always assumed to be 0 feet
2) Dissipation depth = the depth (feet) below surface elevation where the cone advancement was paused while waiting for equilibrium pore pressure to be achieved
3) Equilibrium pore pressure = the pore pressure after an elapsed time where no increase or decrease in pore pressure is occurring, in pounds per square inch (psi)
4) Unit weight of water = 62.3 pounds per cubic foot (lb/ft^3)
5) Unit conversion factor (for dimensional analysis): 1 psi = 144 lb/ft^3

From the dissipation plots, simply read the dissipation depth and dissipated pressure for the values to plug into the equation above. On the plots, pore pressure (psi) is on the abscissa and log time (seconds) is on the ordinate.

Sampling Description

Geoprobe® brand Dual Tube Sampling Systems are efficient methods of collecting continuous soil cores with the added benefit of a cased hole. Dual tube sampling uses two sets of probe rods to collect continuous soil cores. One set of rods is driven into the ground as an outer casing (2.2 or 3.25 inches in diameter). These rods receive the driving force from the hammer and provide a sealed hole from which soil samples may be recovered without the threat of cross contamination. The second, smaller set of rods are placed inside the outer casing. The smaller rods hold a sample liner in place as the outer casing is driven one sampling interval. The small rods are then retracted to retrieve the filled liner. Soil samples are collected in 1.85-inch diameter or 1.125-inch diameter clear PVC sample sheaths.

Interpretations

Soil behavior type (SBT), SPT N60 energy ratio, undrained shear strength, OCR, and unit weights are calculated and/or are interpretations generated by the CPT-Pro software based on empirical relationships derived in the following references;

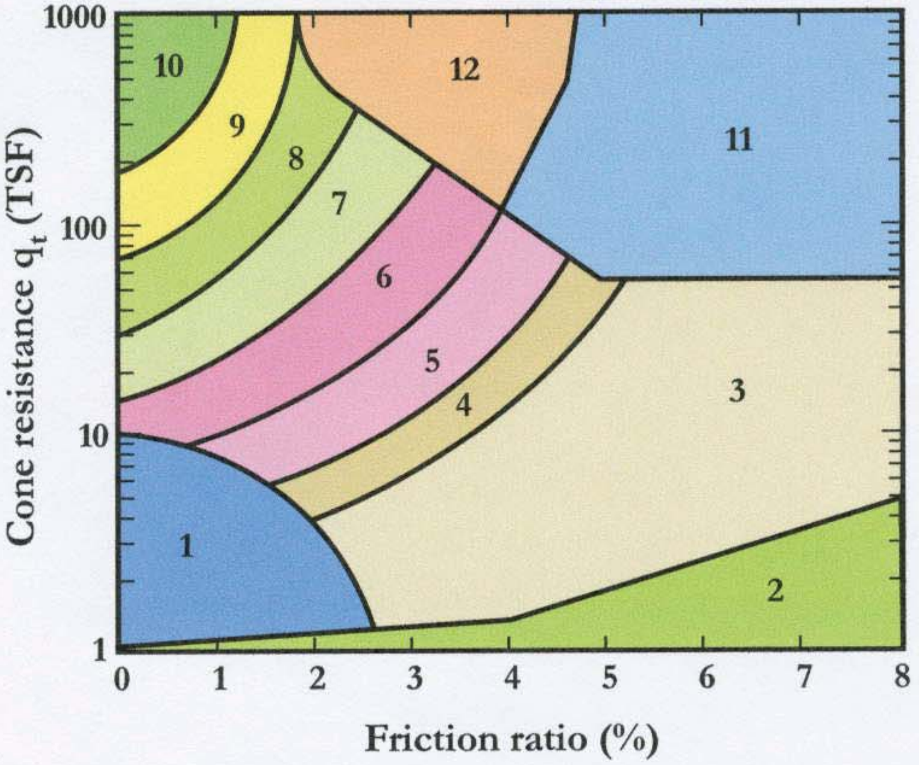
> P.K. Robertson, R.G. Campanella, D. Gillespie, and J. Greig, 1986, Use of Piezometer Cone Data, Proceedings of the ASCE Specialty Conference In Situ '86: Use of In Situ Tests in Geotechnical Engineering; pp. 1263-1280.
>
> P.K. Roberston, 1990, Soil Classification Using the Cone Penetration Test, Canadian Geotechnical Journal, 27(1), pp. 151-158.
>
> T. Lunne, P.K. Robertson, and J.J.M. Powell, 1997, Cone Penetration in Geotechnical Practice, Taylor and Francis Publishing.

CPT Inc. makes no recommendation on which soil behavior type analysis is "most-correct". The engineer should be aware of the limitations of using CPT data to derive soil behavior type and other engineering parameters and is encouraged to review the above references to better understand the applicability and limitations of CPT data. It is sometimes not possible to determine soil type based solely on tip resistance, sleeve friction, and dynamic pore pressure response, and confirmatory samples may be required.

Please do not hesitate to contact CPT Inc. if you have questions.

Sincerely,
John Rogie

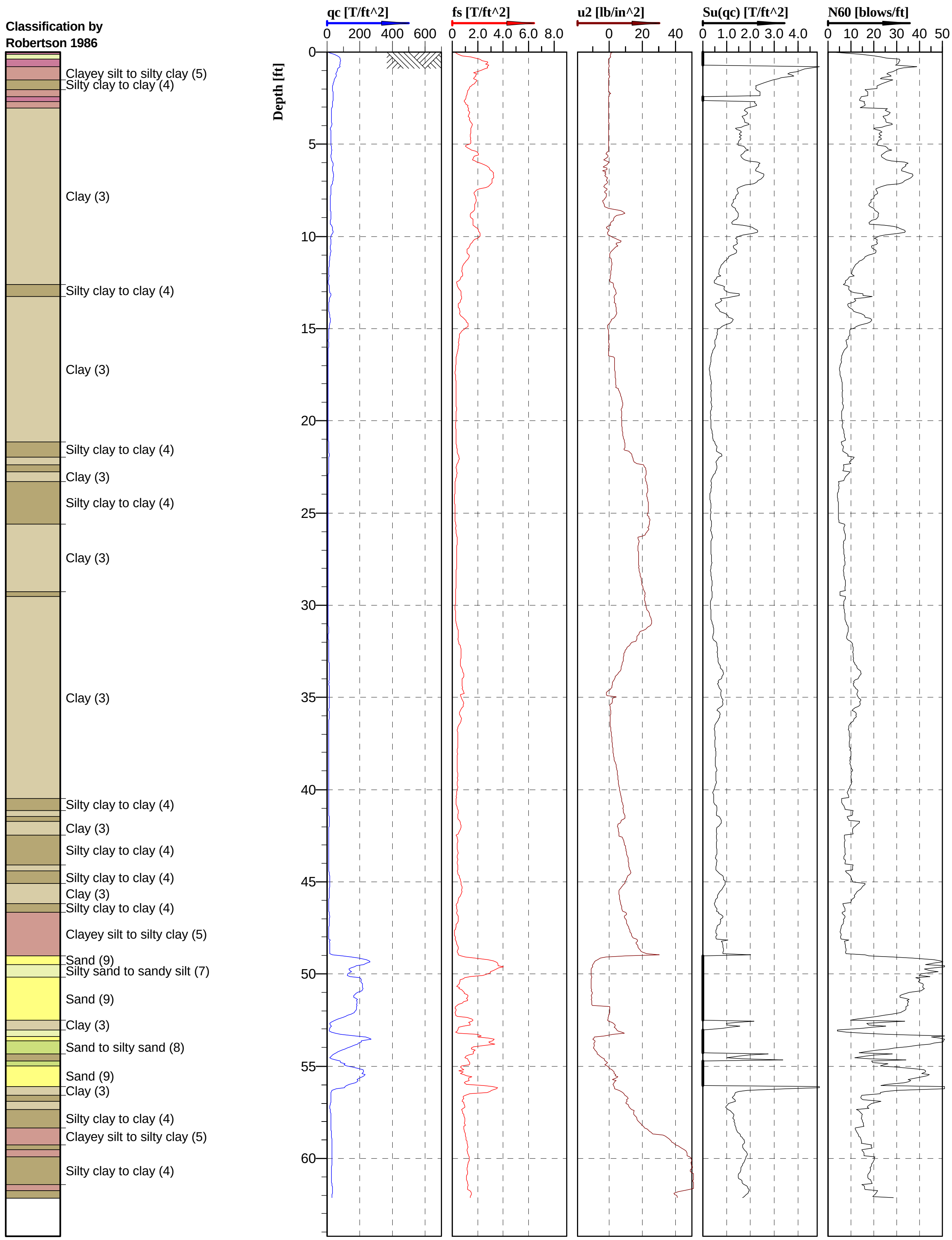
President
California Push Technologies, Inc.



Zone	Soil Behavior Type
1	sensitive fine grained
2	organic material
3	clay
4	silty clay to clay
5	clayey silt to silty clay
6	sandy silt to clayey silt
7	silty sand to sandy silt
8	sand to silty sand
9	sand
10	gravelly sand to sand
11	very stiff fine grained (overconsolidated or cemented)
12	sand to clayey sand (overconsolidated or cemented)

Source: Robertson, P.K., Campanella, R.G., Gillespie, D., and Greig, J., 1986, Use of Piezometer Cone Data. Proceedings of the ASCE Specialty Conference In Situ 86: Use of In Situ Tests in Geotechnical Engineering.

Soil Behavior Type (SBT) Model



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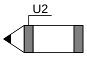

Cone No: 3789
Tip area [cm2]: 10
Sleeve area [cm2]: 150

Location: Gilroy, California	Position:	Ground level:	Test no: CPT-49_00E
Project ID: 115400	Client: GEI	Date: 12/27/2011	Scale: 1 : 90
Project: Lower Llagas Creek Capacity Restoration Project		Page: 1/1	Fig:
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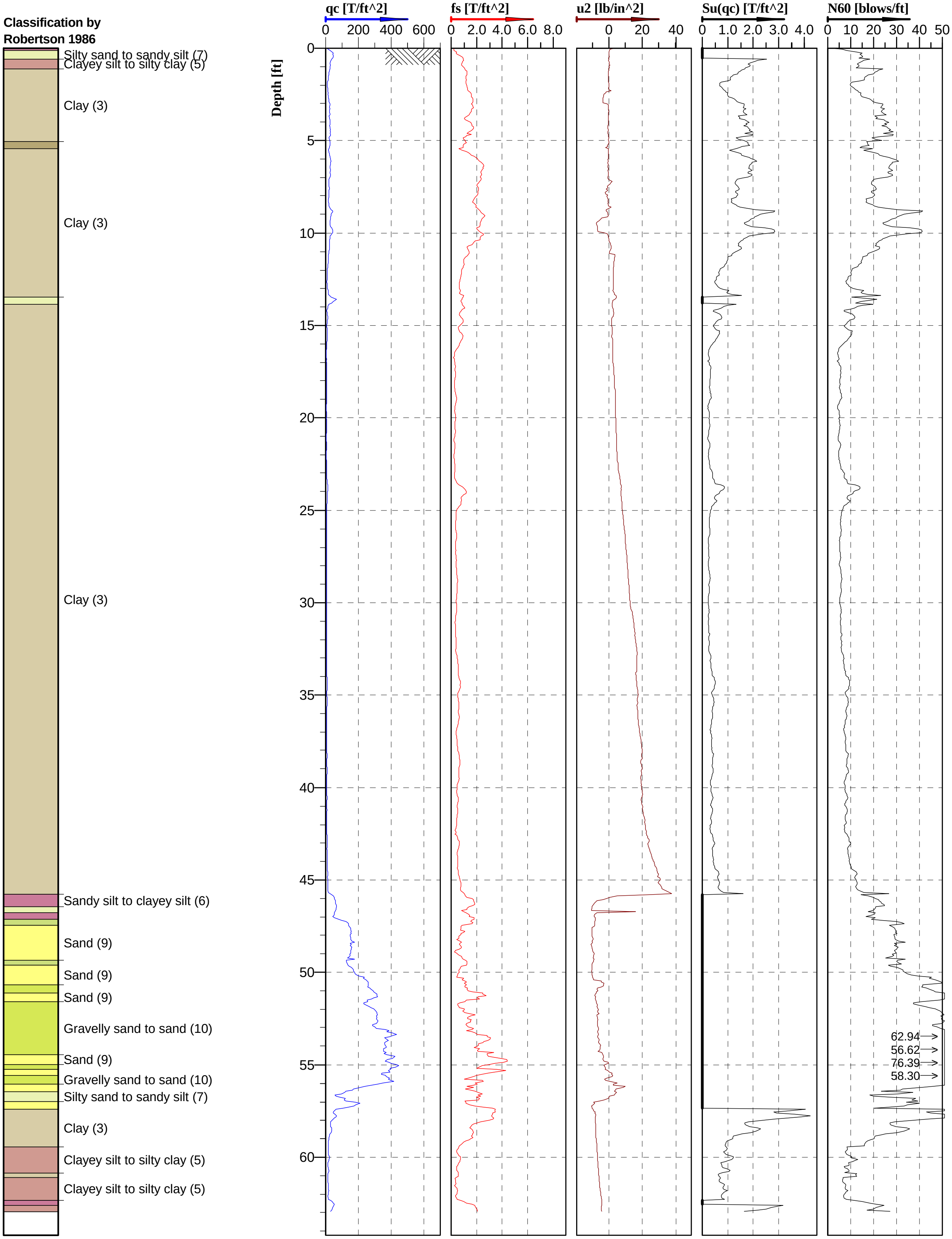

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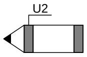

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Tip area [cm2]: 10
Sleeve area [cm2]: 150

Location: Gilroy, California	Position:	Ground level:	Test no: CPT-50_00W
Project ID: 115400	Client: GEI	Date: 12/12/2011	Scale: 1 : 90
Project: Lower Llagas Creek Capacity Restoration Project		Page: 1/1	Fig:
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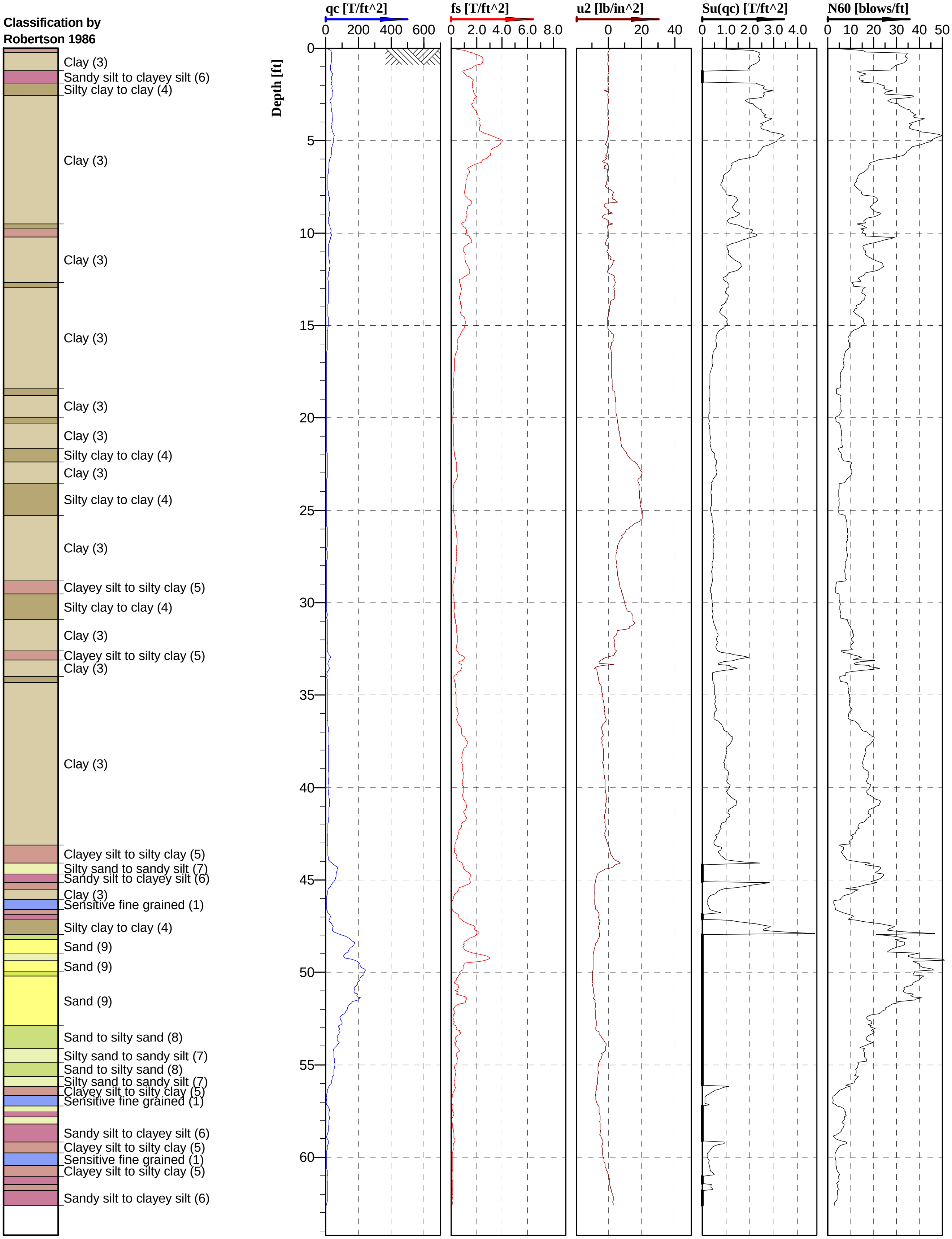

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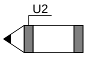

Cone No: 3789
Tip area [cm2]: 10
Sleeve area [cm2]: 150

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Project ID: 115400	Client: GEI	Date: 12/27/2011	Scale: 1 : 90
Project: Lower Llagas Creek Capacity Restoration Project		Page: 1/1	Fig:
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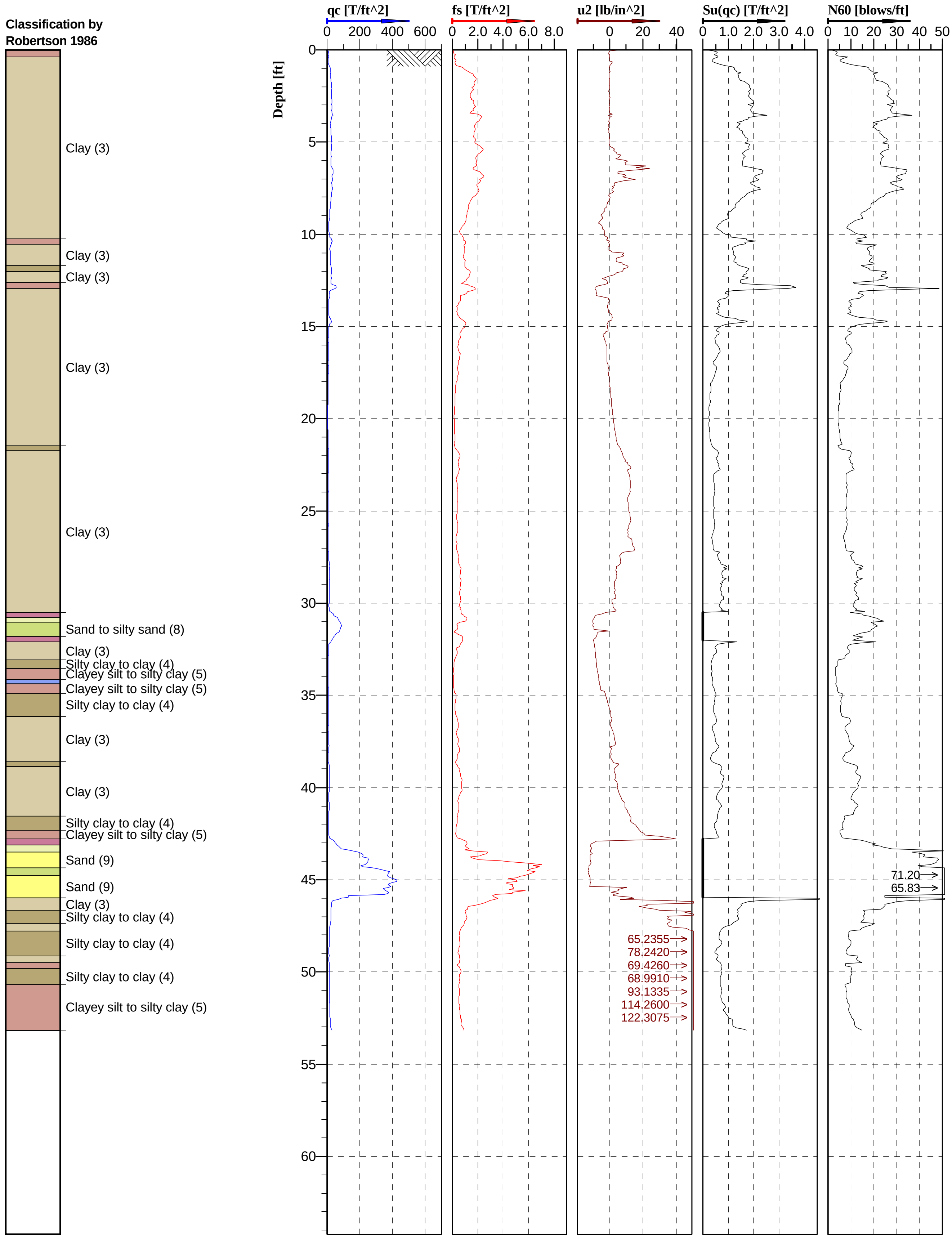

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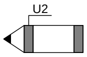

Cone No: 3789
Tip area [cm2]: 10
Sleeve area [cm2]: 150

Location: Gilroy, California	Position:	Ground level:	Test no: CPT-61_50W
Project ID: 115400	Client: GEI	Date: 12/12/2011	Scale: 1 : 90
Project: Lower Llagas Creek Capacity Restoration Project		Page: 1/1	Fig:
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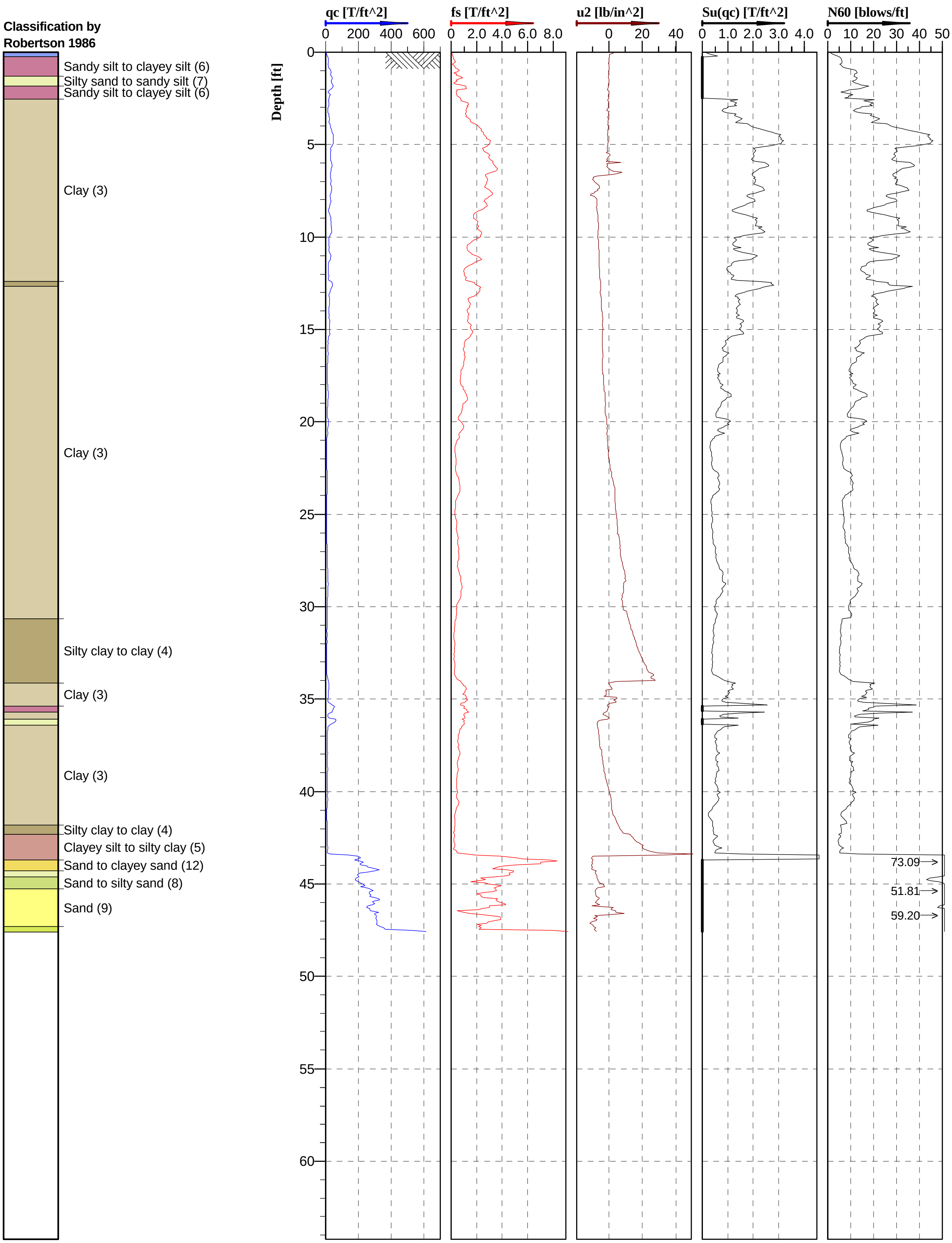

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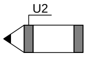

Cone No: 3789
Tip area [cm2]: 10
Sleeve area [cm2]: 150

Location: Gilroy, California	Position:	Ground level:	Test no: CPT-69_00W
Project ID: 115400	Client: GEI	Date: 12/12/2011	Scale: 1 : 90
Project: Lower Llagas Creek Capacity Restoration Project		Page: 1/1	Fig:
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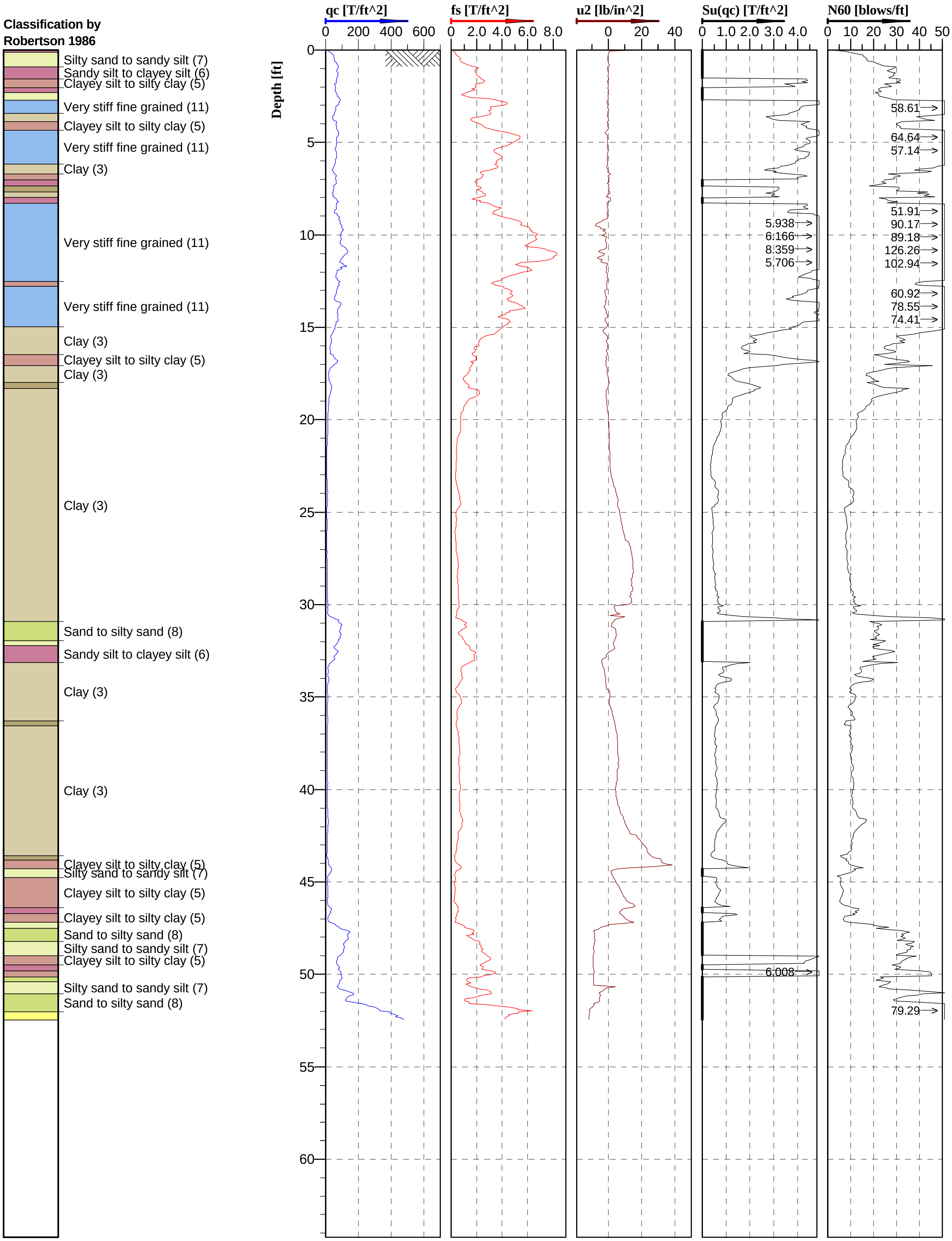

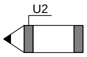

Cone No: 3789
Tip area [cm2]: 10
Sleeve area [cm2]: 150

Location: Gilroy, California	Position:	Ground level:	Test no: CPT-74_50E
Project ID: 115400	Client: GEI	Date: 12/27/2011	Scale: 1 : 90
Project: Lower Llagas Creek Capacity Restoration Project		Page: 1/1	Fig:
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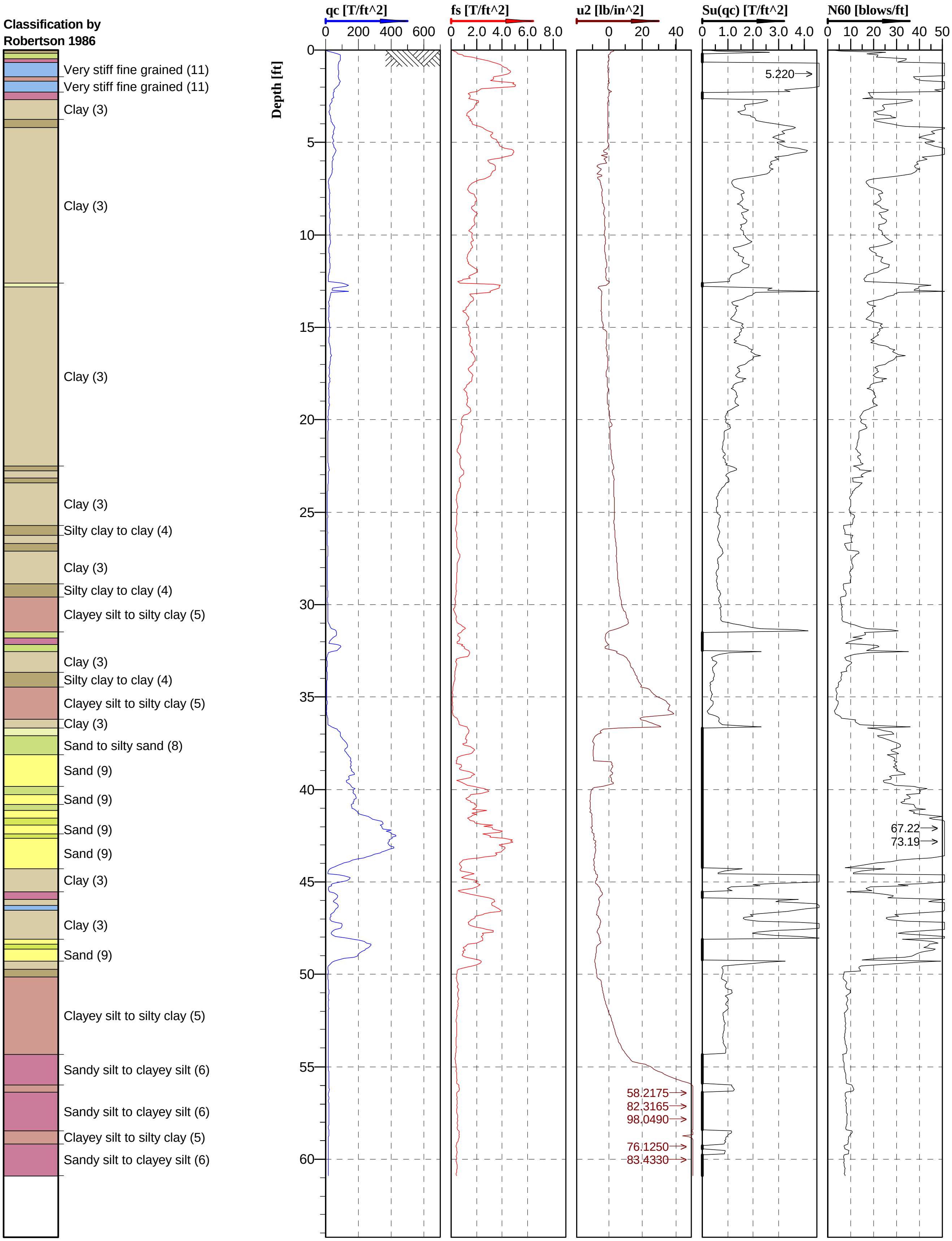

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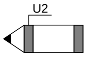

Cone No: 3789
Tip area [cm2]: 10
Sleeve area [cm2]: 150

Location: Gilroy, California	Position:	Ground level:	Test no: CPT-78_00W
Project ID: 115400	Client: GEI	Date: 12/12/2011	Scale: 1 : 90
Project: Lower Llagas Creek Capacity Restoration Project		Page: 1/1	Fig:
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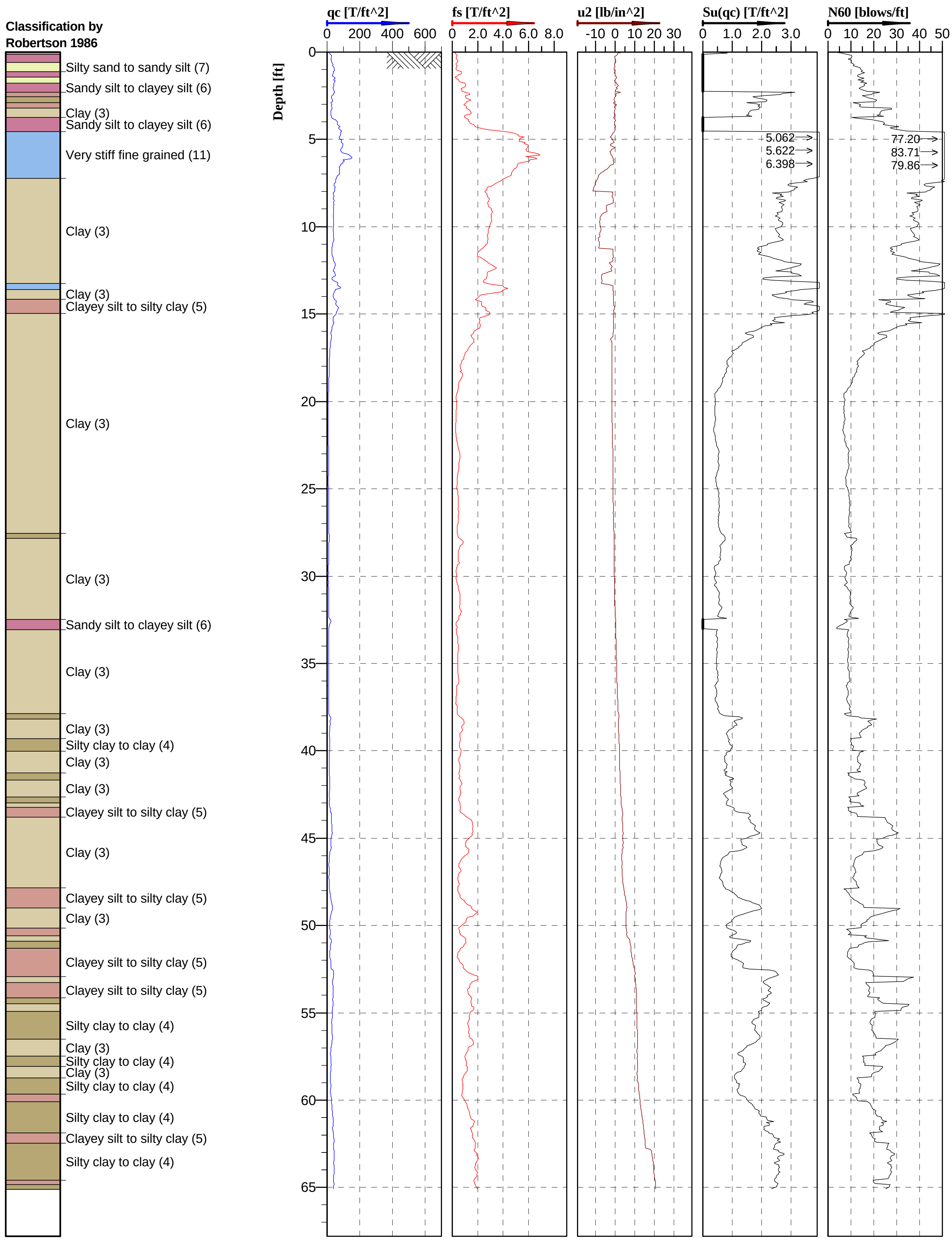

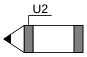

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Cone No: 3789
Tip area [cm2]: 10
Sleeve area [cm2]: 150

Location: Gilroy, California	Position:	Ground level:	Test no: CPT-83_00E
Project ID: 115400	Client: GEI	Date: 1/11/2012	Scale: 1 : 95
Project: Lower Llagas Creek Capacity Restoration Project		Page: 1/1	Fig:
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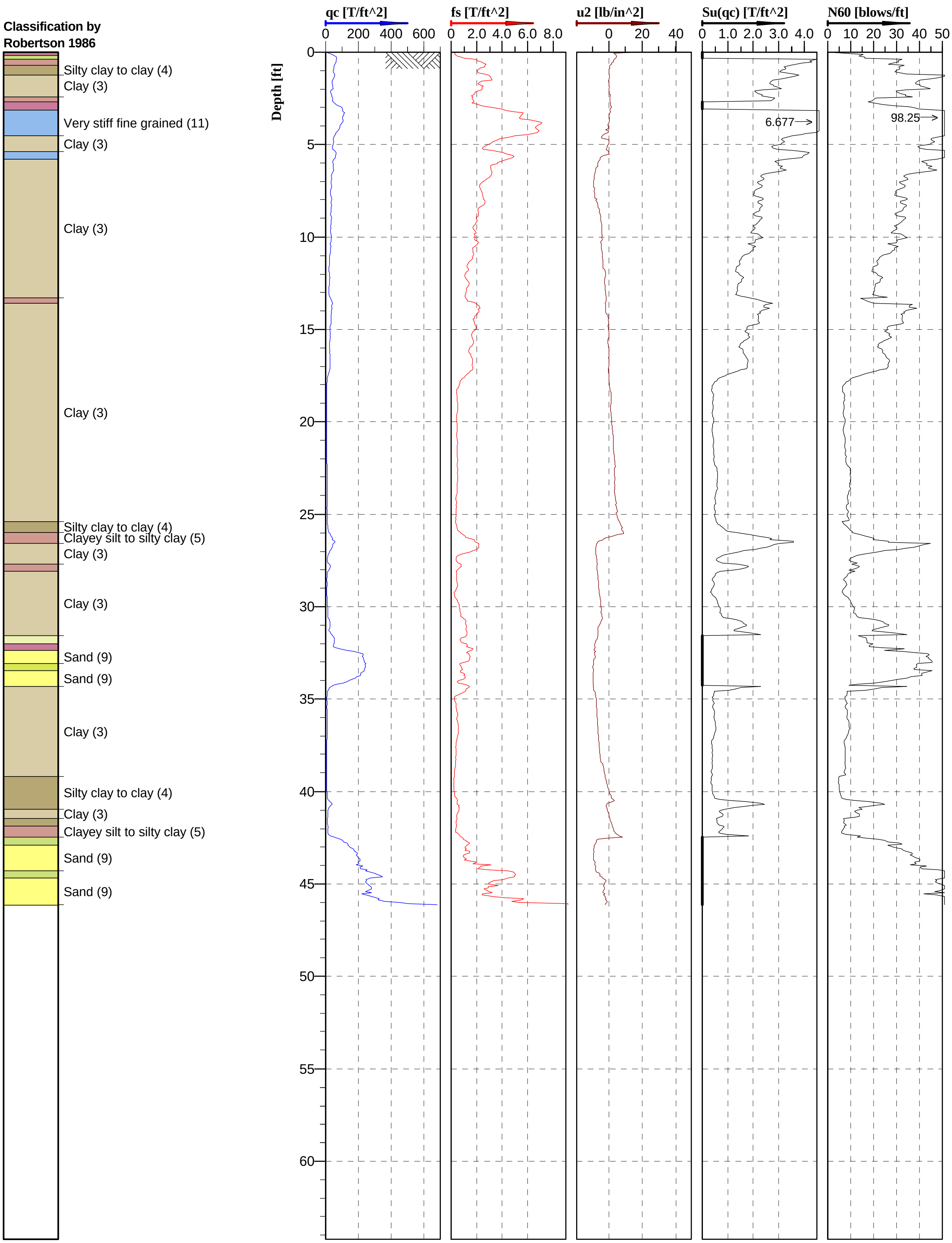

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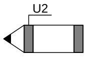

Cone No: 3789
Tip area [cm2]: 10
Sleeve area [cm2]: 150

Location: Gilroy, California	Position:	Ground level:	Test no: CPT-88_00W
Project ID: 115400	Client: GEI	Date: 12/12/2011	Scale: 1 : 90
Project: Lower Llagas Creek Capacity Restoration Project		Page: 1/1	Fig:
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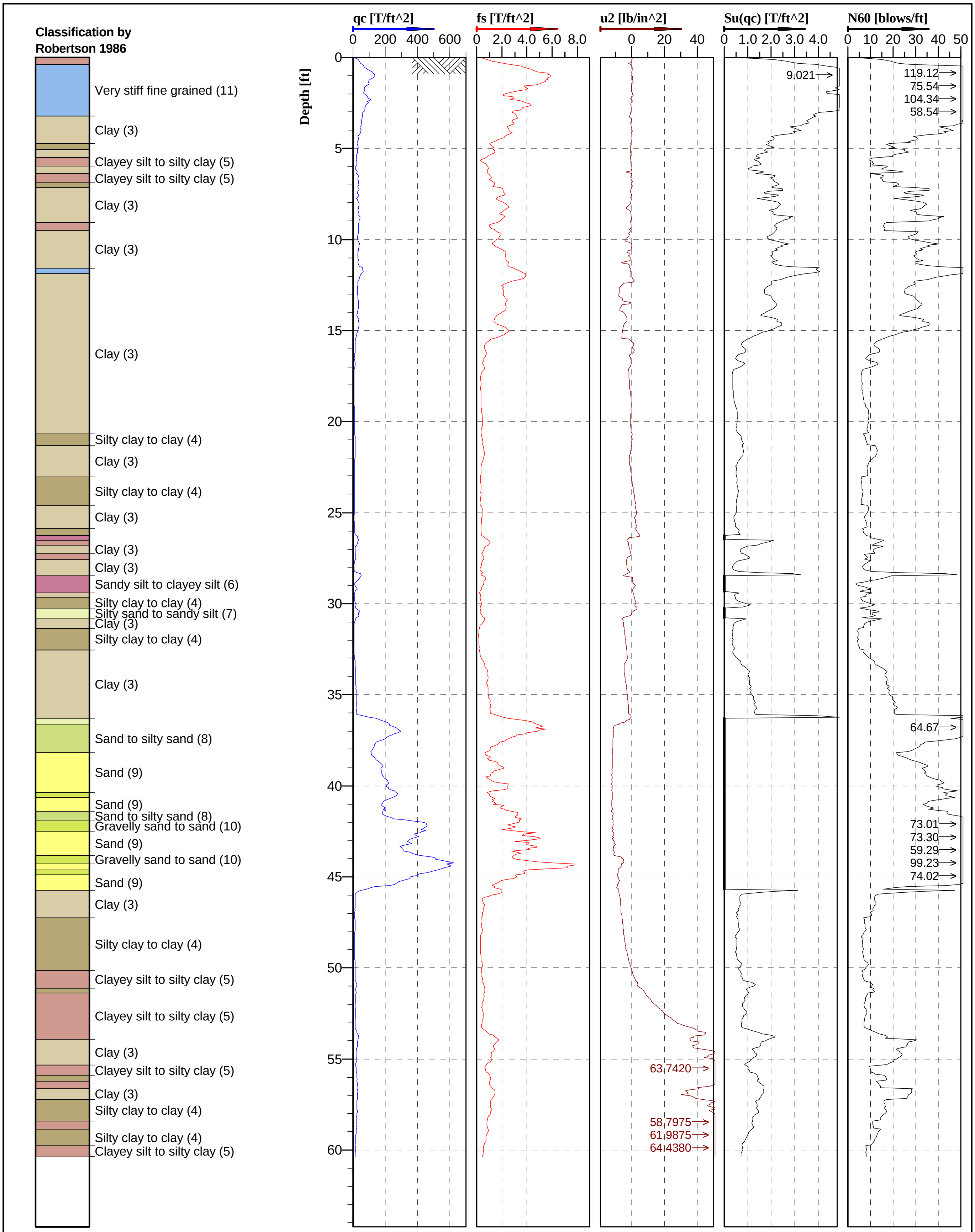

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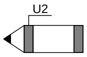

Cone No: 3789
Tip area [cm2]: 10
Sleeve area [cm2]: 150

Location: Gilroy, California	Position:	Ground level:	Test no: CPT-92_50E
Project ID: 115400	Client: GEI	Date: 12/27/2011	Scale: 1 : 90
Project: Lower Llagas Creek Capacity Restoration Project		Page: 1/1	Fig:
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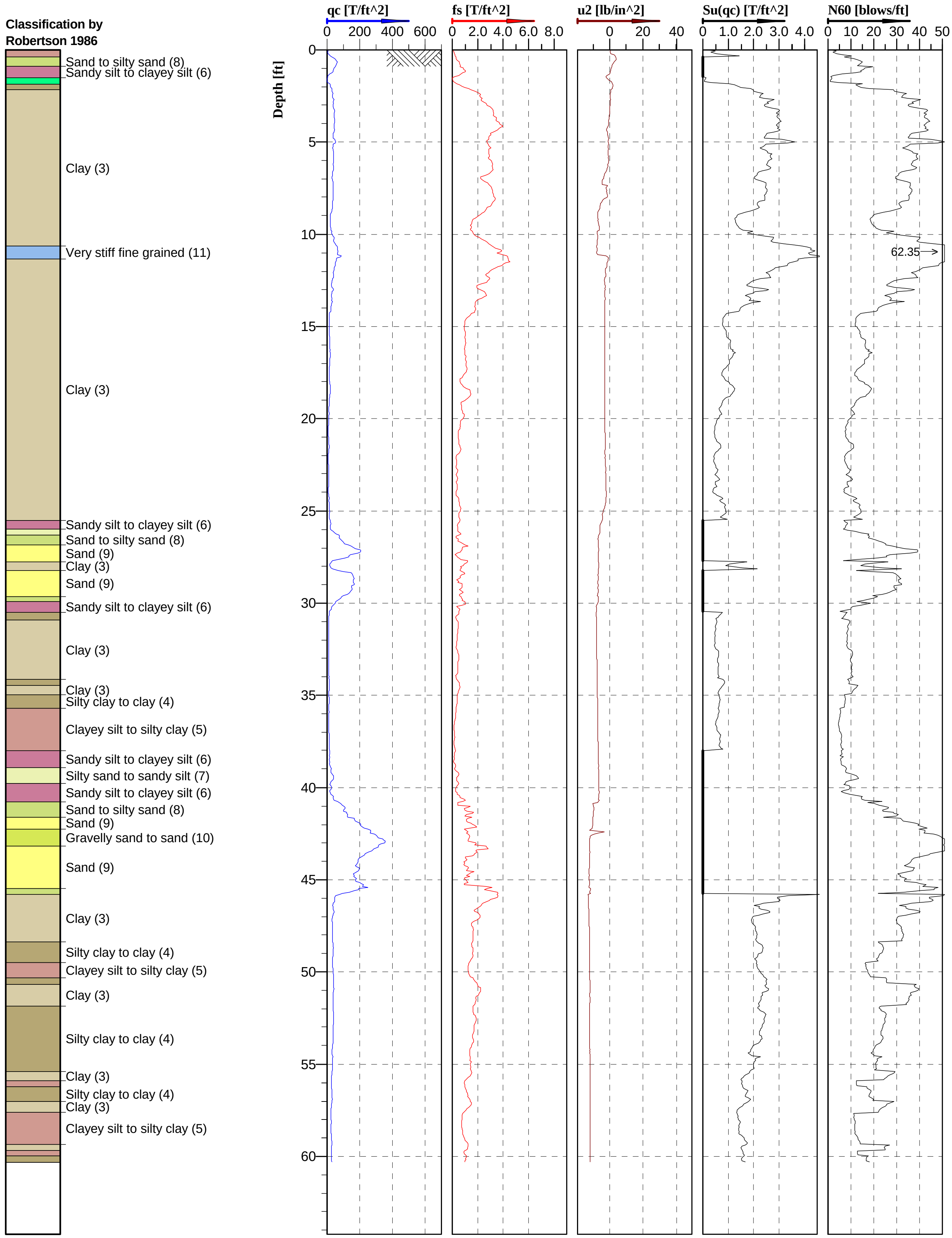

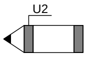

Cone No: 3789
Tip area [cm2]: 10
Sleeve area [cm2]: 150

Location: Gilroy, California	Position:	Ground level:	Test no: CPT-98_50W
Project ID: 115400	Client: GEI	Date: 12/13/2011	Scale: 1 : 90
Project: Lower Llagas Creek Capacity Restoration Project		Page: 1/1	Fig:
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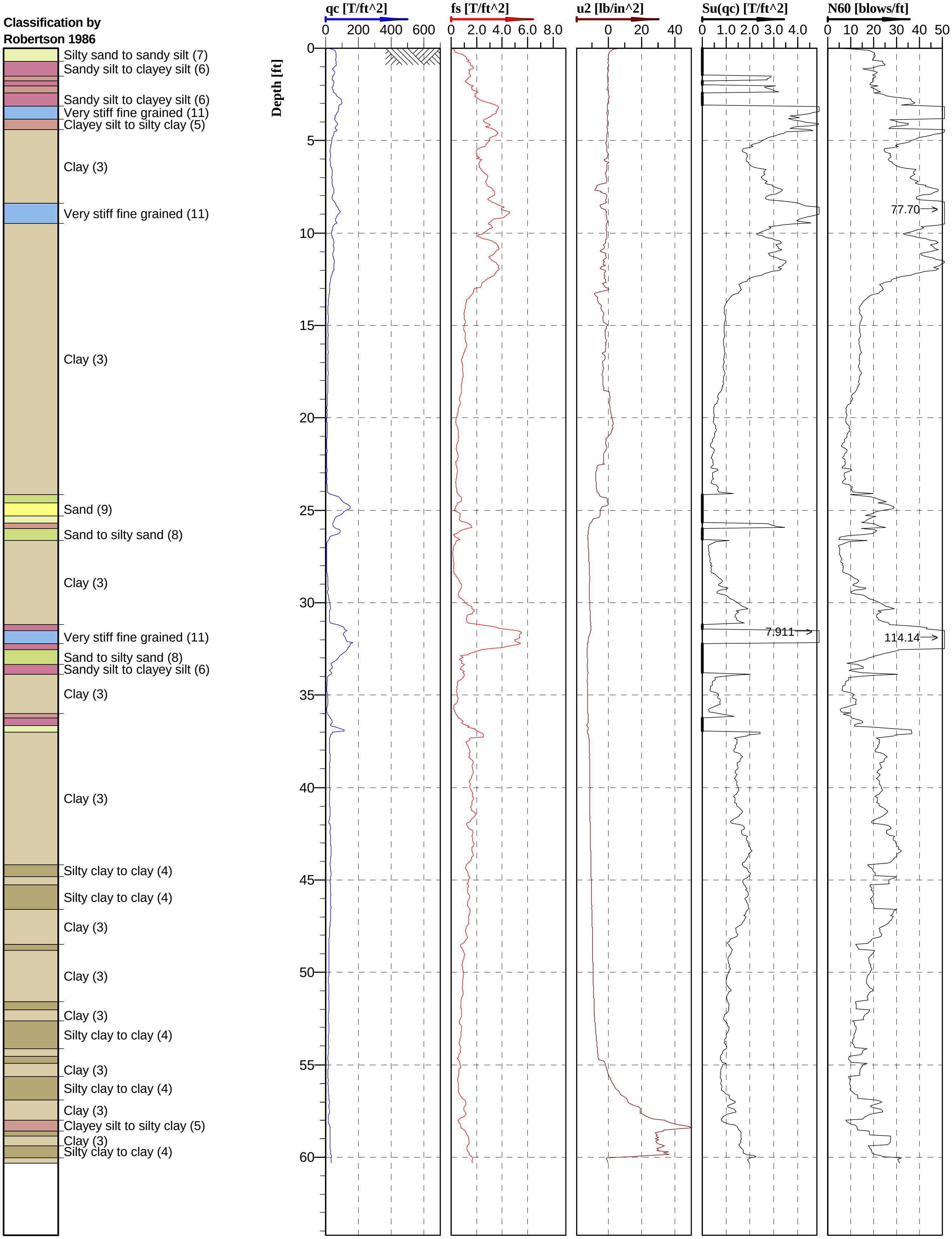

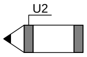

Cone No: 3789
Tip area [cm2]: 10
Sleeve area [cm2]: 150

Location: Gilroy, California	Position:	Ground level:	Test no: CPT-99_50E
Project ID: 115400	Client: GEI	Date: 12/28/2011	Scale: 1 : 90
Project: Lower Llagas Creek Capacity Restoration Project		Page: 1/1	Fig:
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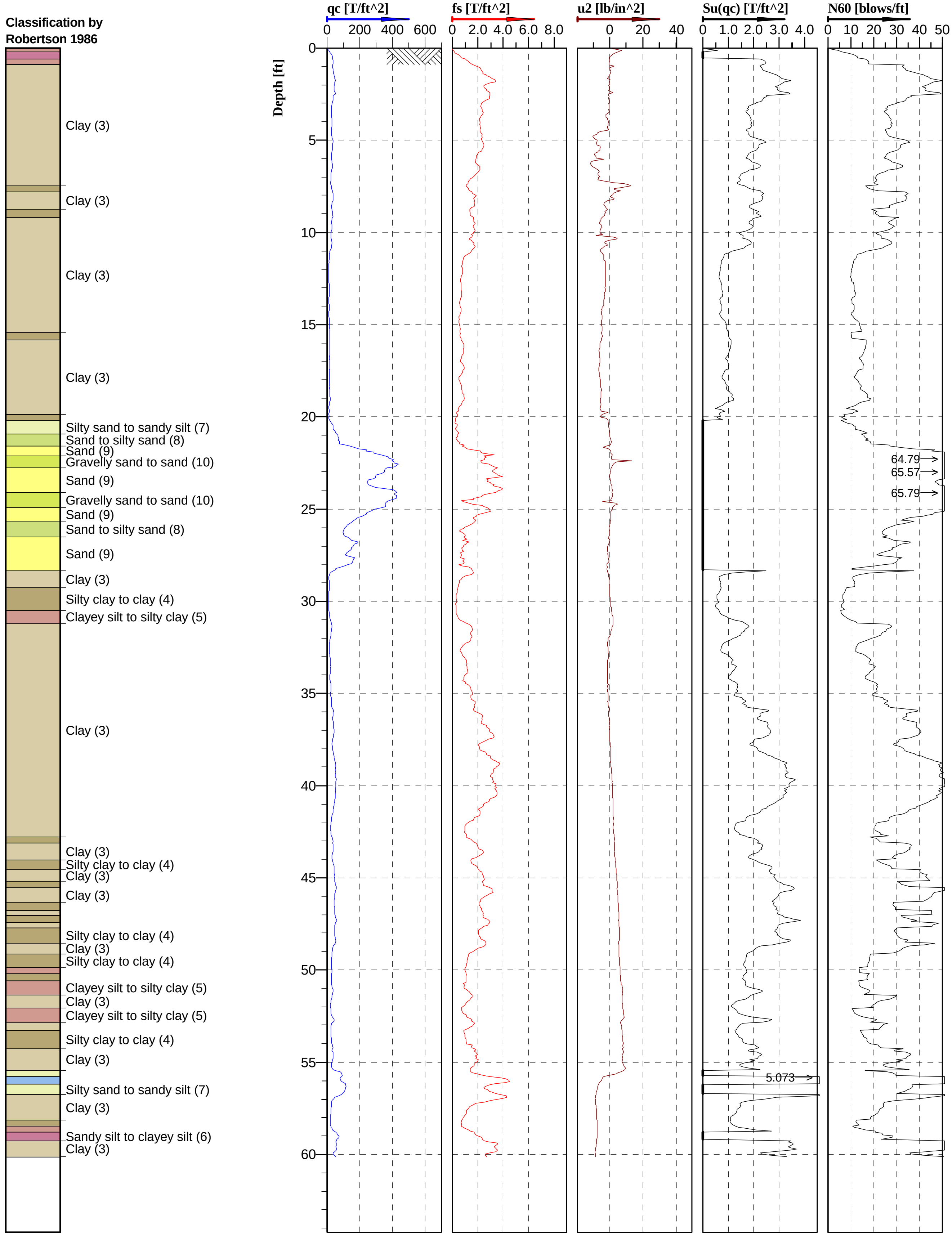

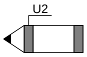

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Cone No: 3789
Tip area [cm2]: 10
Sleeve area [cm2]: 150

Location: Gilroy, California	Position:	Ground level:	Test no: CPT-107_00W
Project ID: 115400	Client: GEI	Date: 12/13/2011	Scale: 1 : 90
Project: Lower Llagas Creek Capacity Restoration Project		Page: 1/1	Fig:
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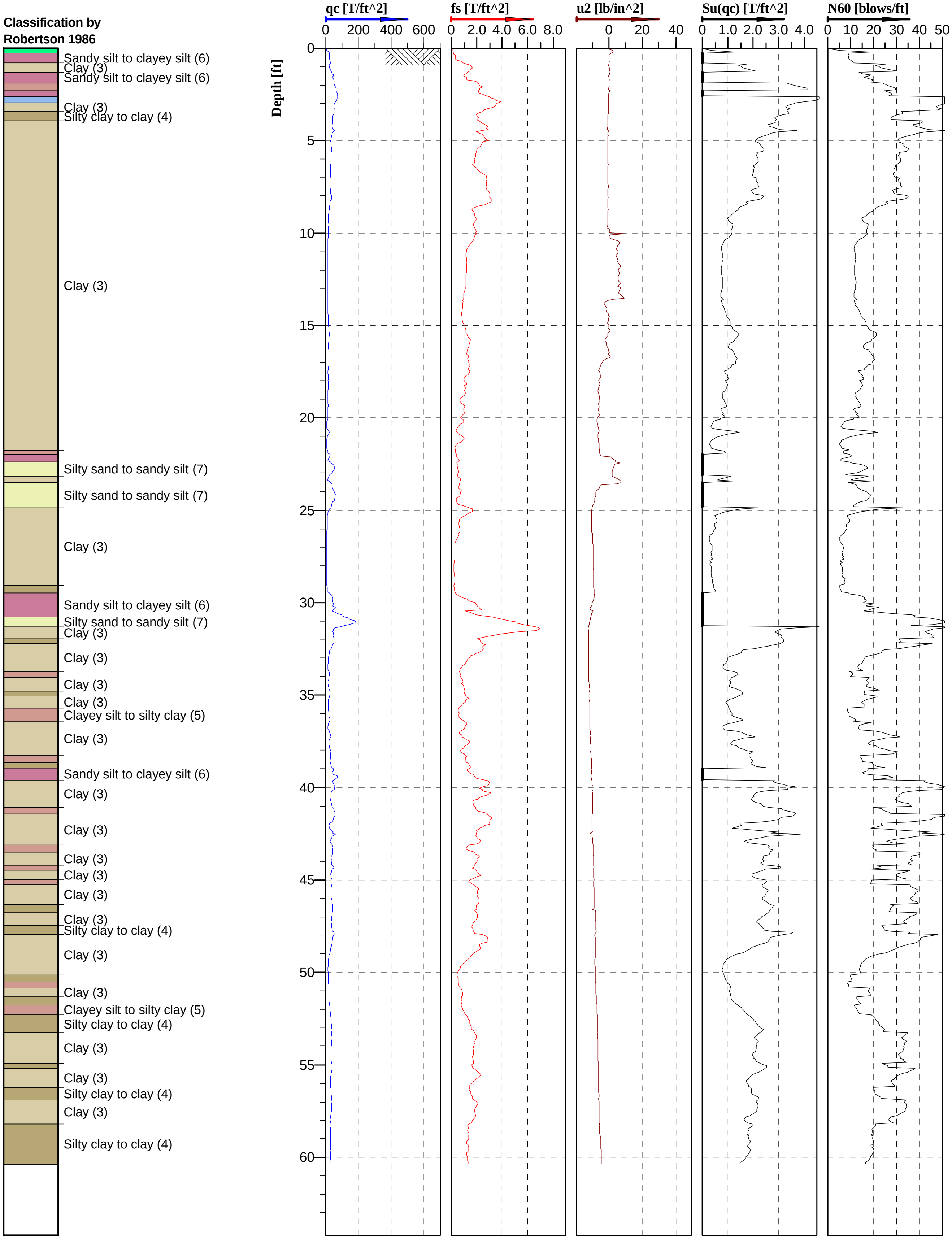

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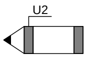

Cone No: 3789
Tip area [cm2]: 10
Sleeve area [cm2]: 150

Location: Gilroy, California	Position:	Ground level:	Test no: CPT-108_50E
Project ID: 115400	Client: GEI	Date: 12/14/2011	Scale: 1 : 90
Project: Lower Llagas Creek Capacity Restoration Project		Page: 1/1	Fig:
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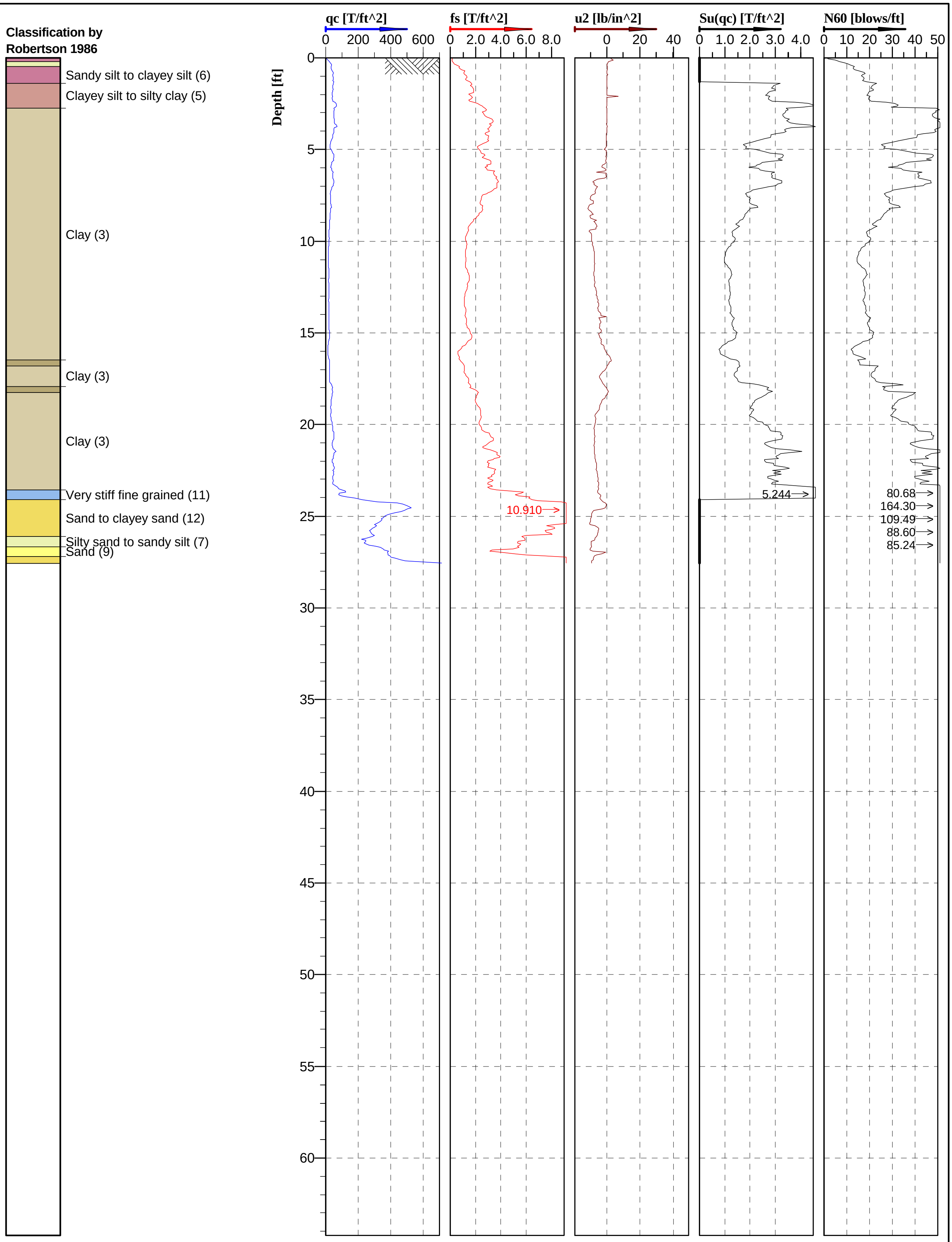

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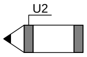

Cone No: 3789
Tip area [cm2]: 10
Sleeve area [cm2]: 150

Location: Gilroy, California	Position:	Ground level:	Test no: CPT-114_00W
Project ID: 115400	Client: GEI	Date: 12/14/2011	Scale: 1 : 90
Project: Lower Llagas Creek Capacity Restoration Project		Page: 1/1	Fig:
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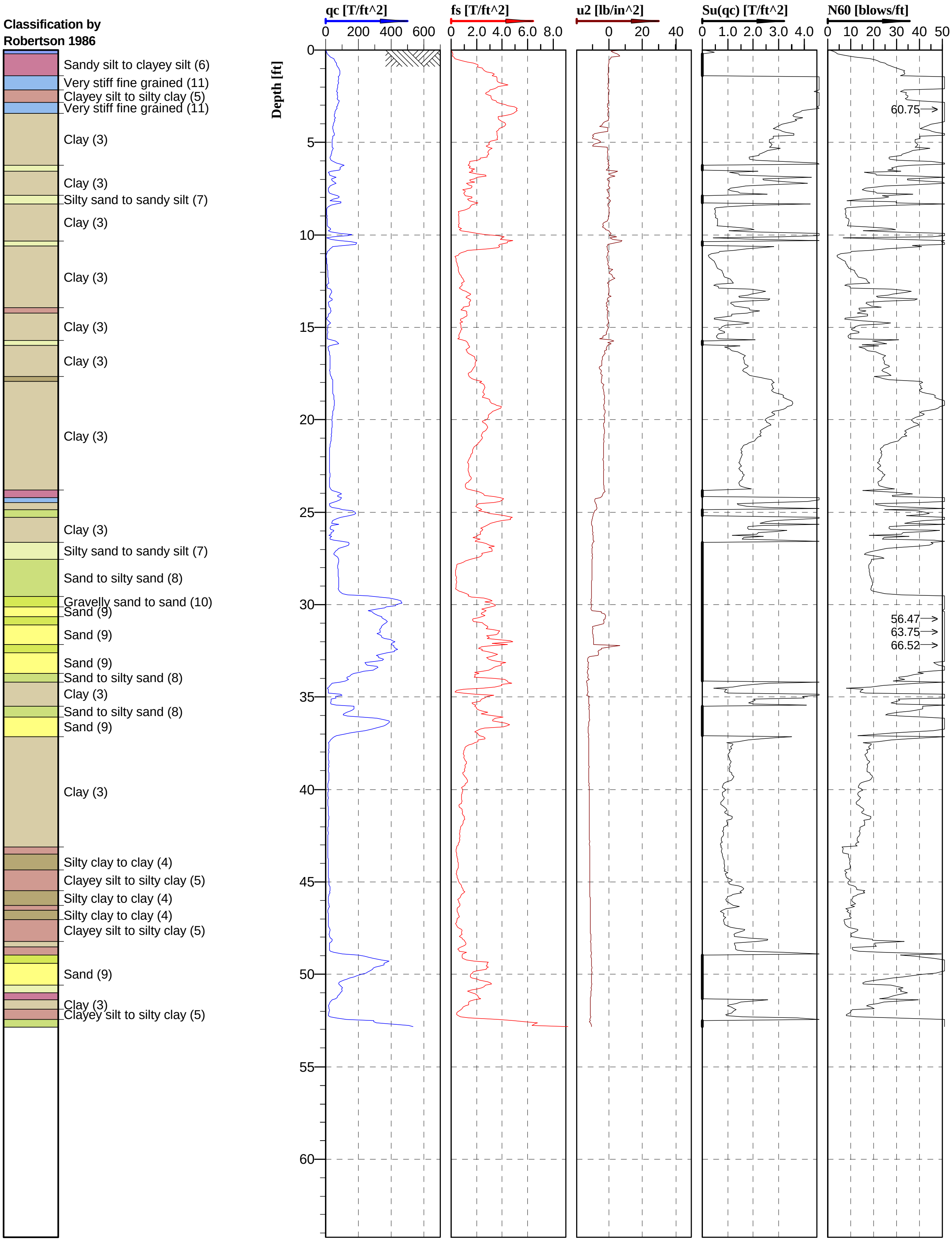
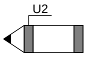
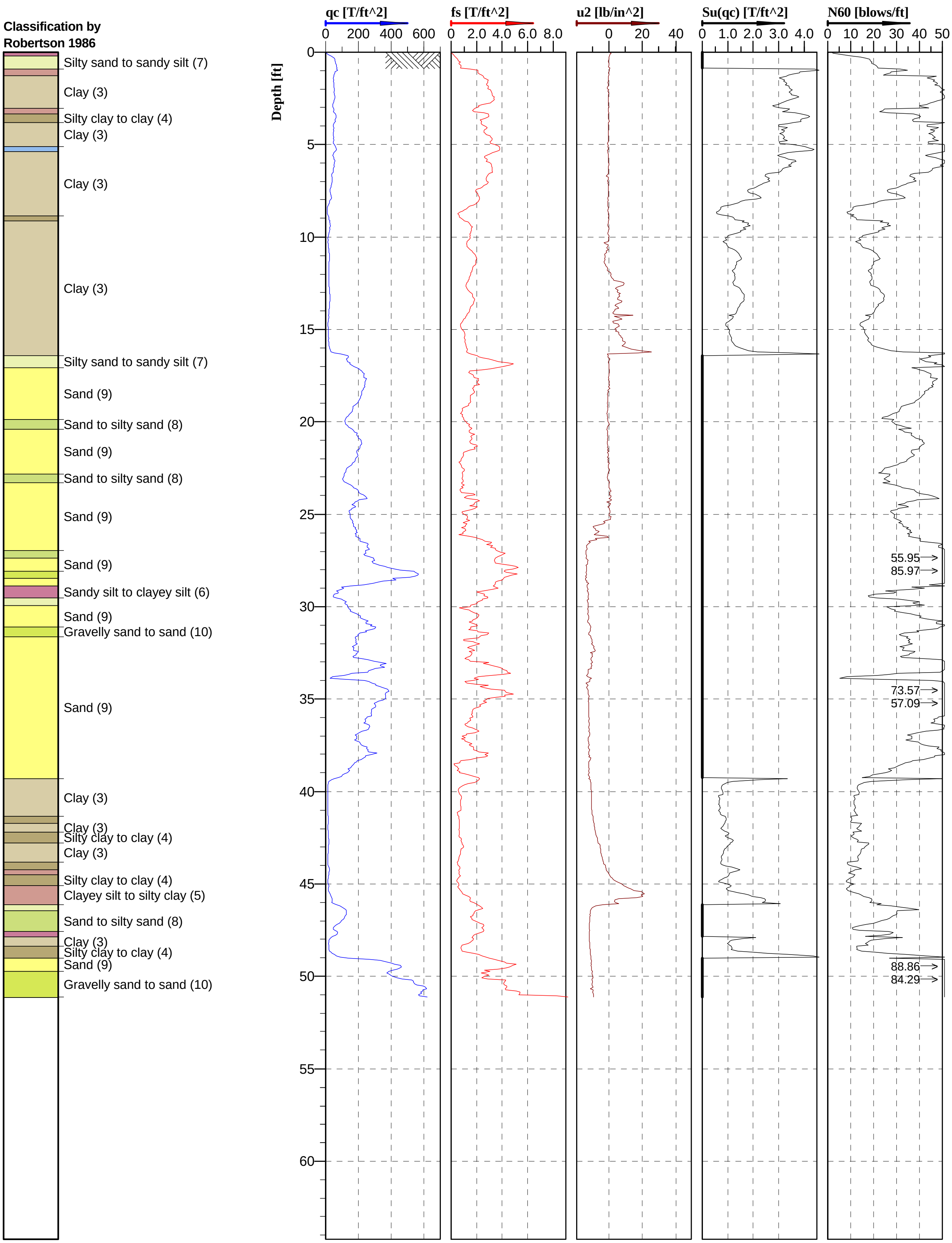
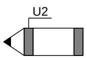




Cone No: 3789
Tip area [cm2]: 10
Sleeve area [cm2]: 150

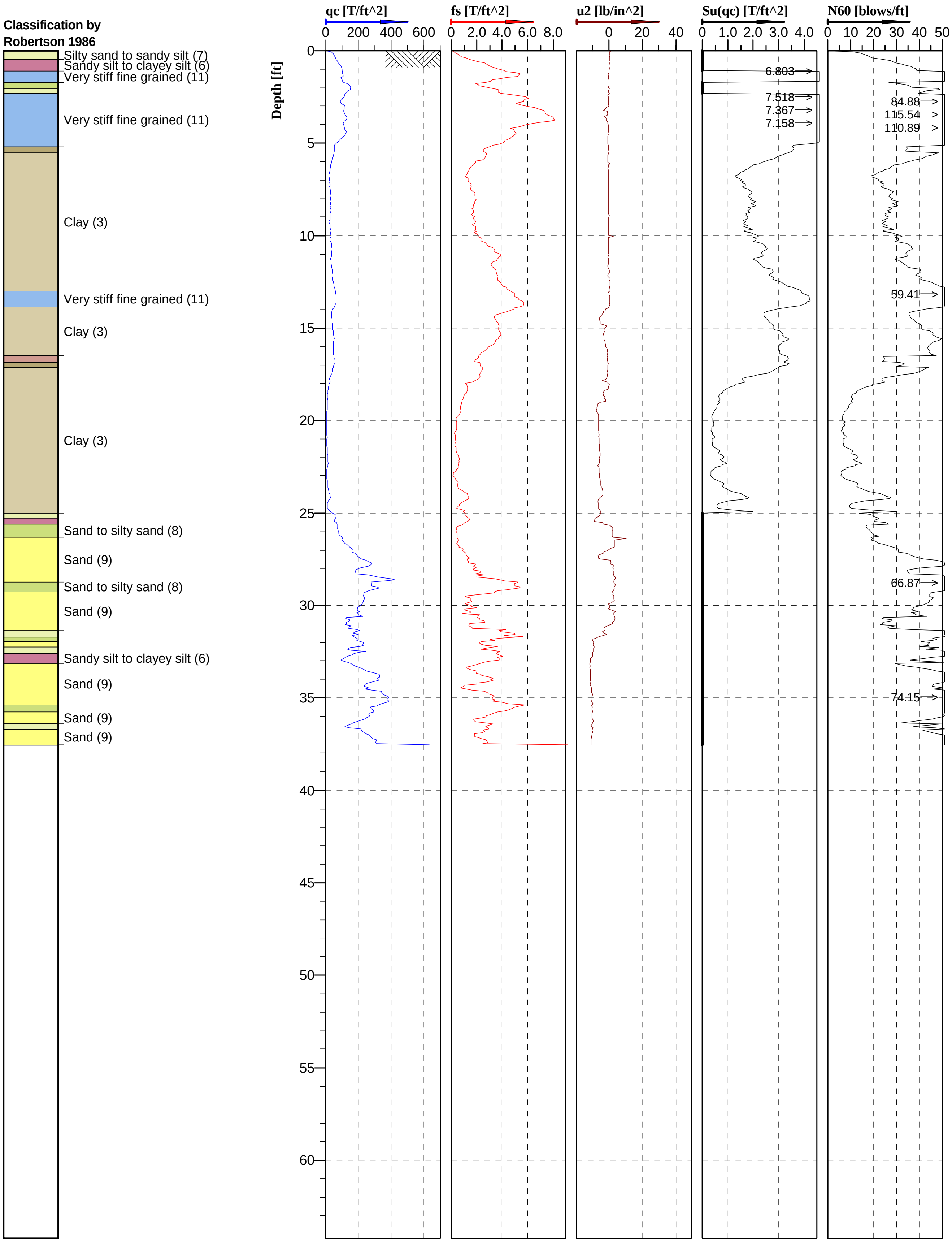
Location: Gilroy, California	Position:	Ground level:	Test no: CPT-119_50W
Project ID: 115400	Client: GEI	Date: 12/13/2011	Scale: 1 : 90
Project: Lower Llagas Creek Capacity Restoration Project		Page: 1/1	Fig:
		File: CPT-119_50W.cpd	



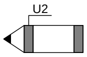


Cone No: 3789
Tip area [cm2]: 10
Sleeve area [cm2]: 150

Location: Gilroy, California	Position:	Ground level:	Test no: CPT-126_00E
Project ID: 115400	Client: GEI	Date: 12/13/2011	Scale: 1 : 90
Project: Lower Llagas Creek Capacity Restoration Project		Page: 1/1	Fig:
		File: CPT-126_00E.cpd	

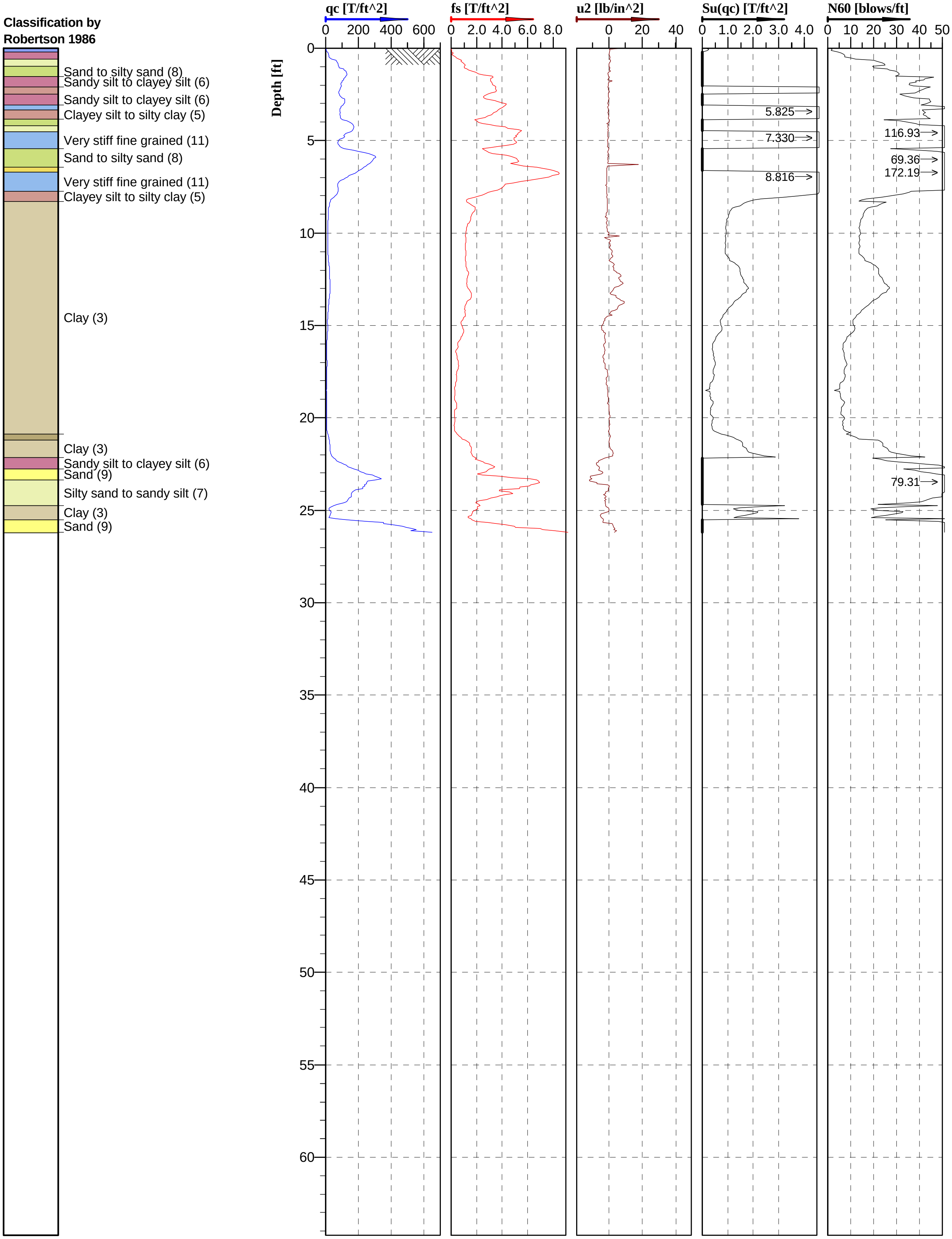


CALIFORNIA PUSH TECHNOLOGIES INCORPORATED

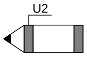


Cone No: 3789
Tip area [cm2]: 10
Sleeve area [cm2]: 150

Location: Gilroy, California	Position:	Ground level:	Test no: CPT-132_00W
Project ID: 115400	Client: GEI	Date: 12/19/2011	Scale: 1 : 90
Project: Lower Llagas Creek Capacity Restoration Project		Page: 1/1	Fig:
		File: CPT-132_00W.cpd	

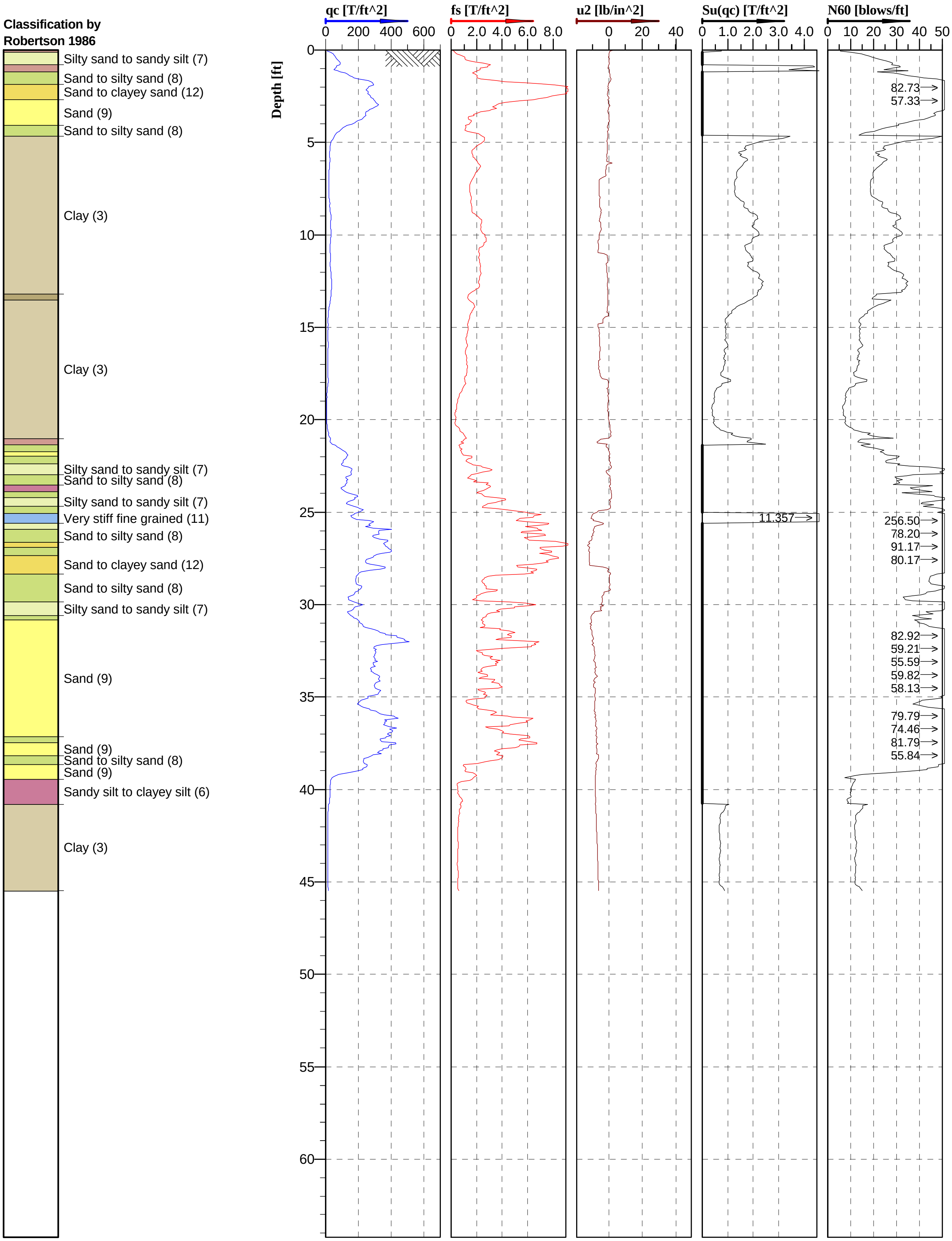


CALIFORNIA PUSH TECHNOLOGIES INCORPORATED



Cone No: 3789
Tip area [cm2]: 10
Sleeve area [cm2]: 150

Location: Gilroy, California	Position:	Ground level:	Test no: CPT-138_50E
Project ID: 115400	Client: GEI	Date: 12/14/2011	Scale: 1 : 90
Project: Lower Llagas Creek Capacity Restoration Project		Page: 1/1	Fig:
		File: CPT-138_50E.cpd	



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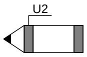
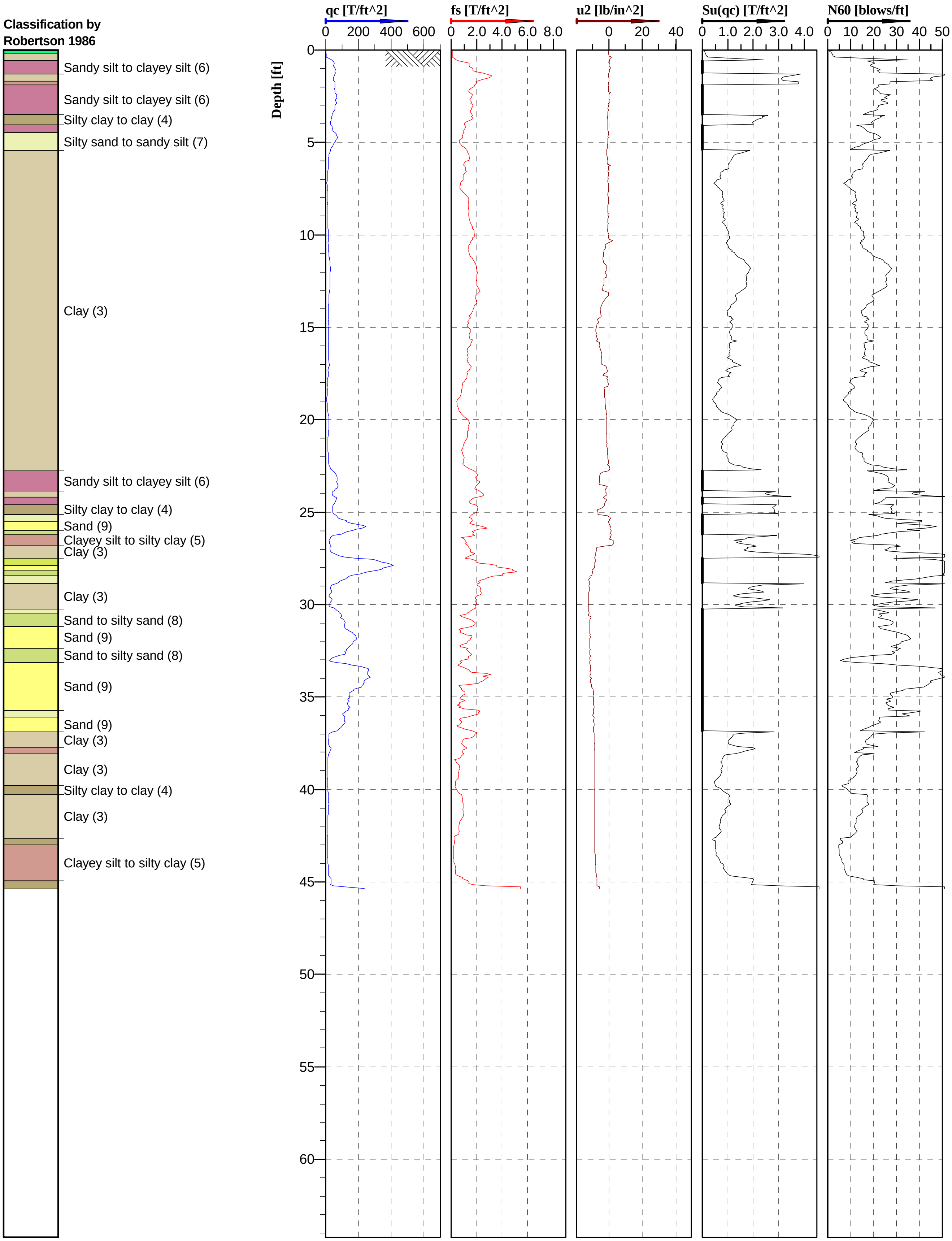


Cone No: 3789
Tip area [cm2]: 10
Sleeve area [cm2]: 150

Location: Gilroy, California	Position:	Ground level:	Test no: CPT-141_00W
Project ID: 115400	Client: GEI	Date: 12/19/2011	Scale: 1 : 90
Project: Lower Llagas Creek Capacity Restoration Project		Page: 1/1	Fig:
		File: CPT-141_00W.cpd	



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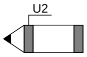
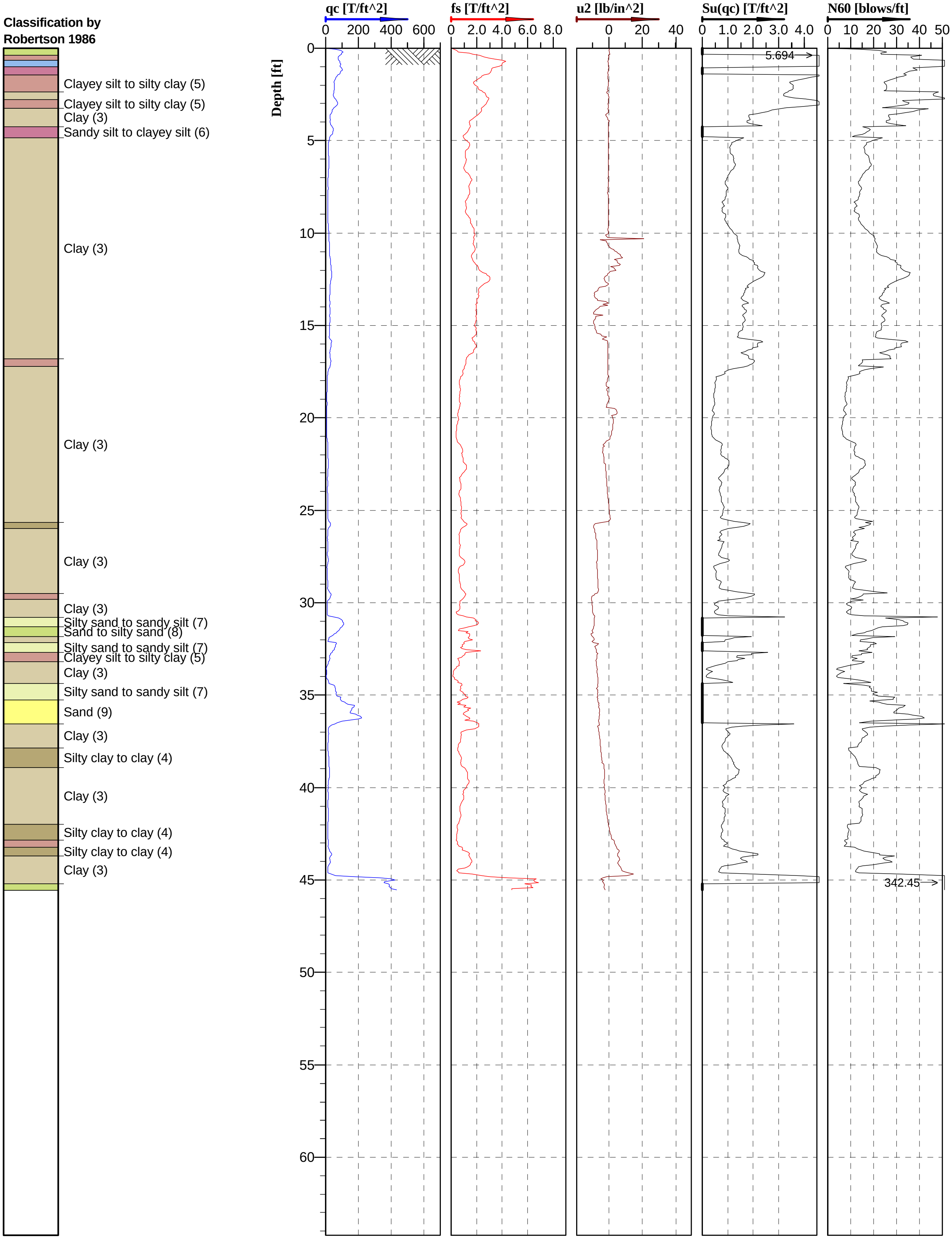
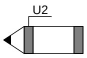


Cone No: 3789
Tip area [cm2]: 10
Sleeve area [cm2]: 150

Location: Gilroy, California	Position:	Ground level:	Test no: CPT-147_50W
Project ID: 115400	Client: GEI	Date: 12/19/2011	Scale: 1 : 90
Project: Lower Llagas Creek Capacity Restoration Project		Page: 1/1	Fig:
		File: CPT-147_50W.cpd	

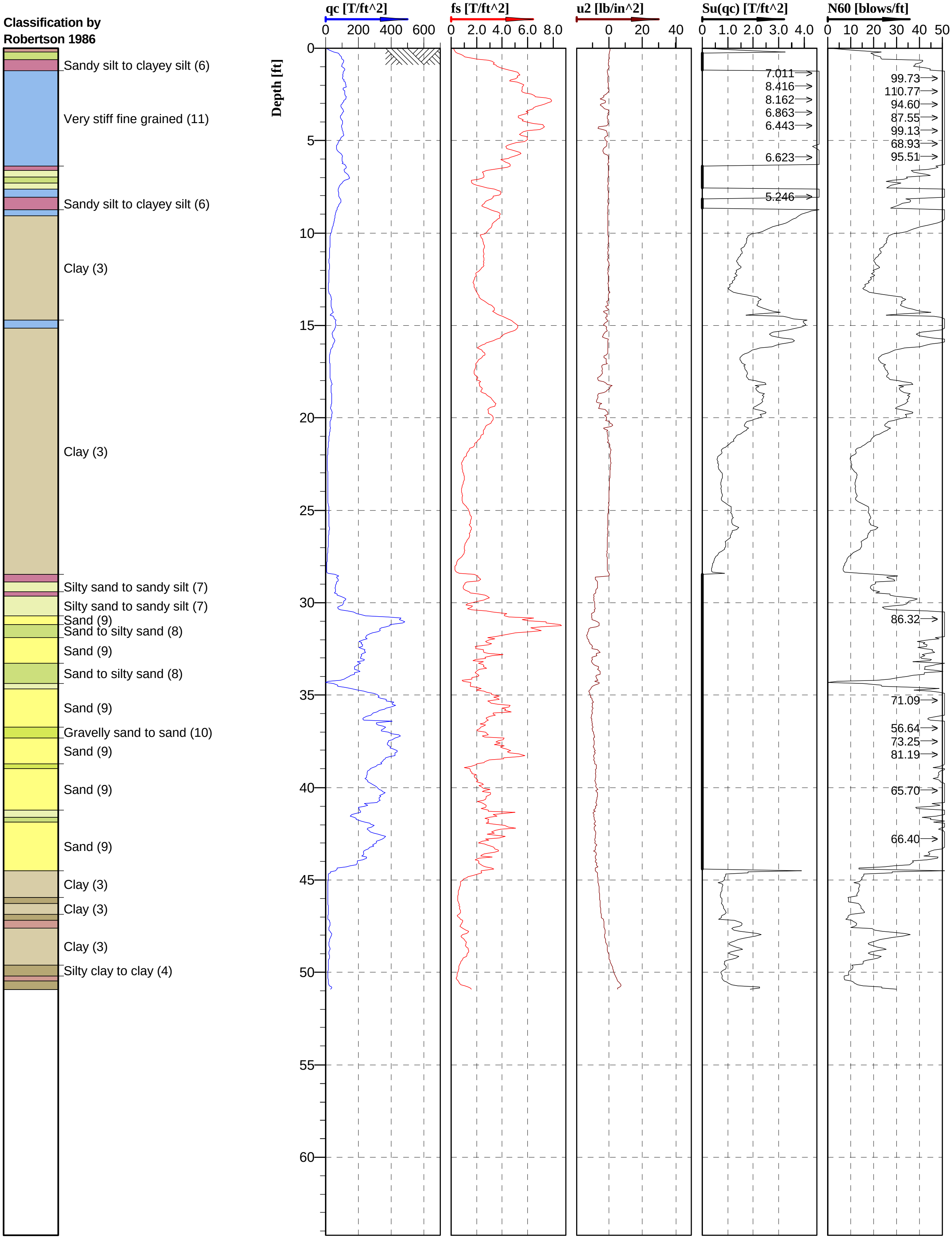


CALIFORNIA PUSH TECHNOLOGIES INCORPORATED



Cone No: 3789
Tip area [cm2]: 10
Sleeve area [cm2]: 150

Location: Gilroy, California	Position:	Ground level:	Test no: CPT-148_00E
Project ID: 115400	Client: GEI	Date: 12/14/2011	Scale: 1 : 90
Project: Lower Llagas Creek Capacity Restoration Project		Page: 1/1	Fig:
		File: CPT-148_00E.cpd	



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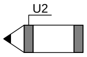
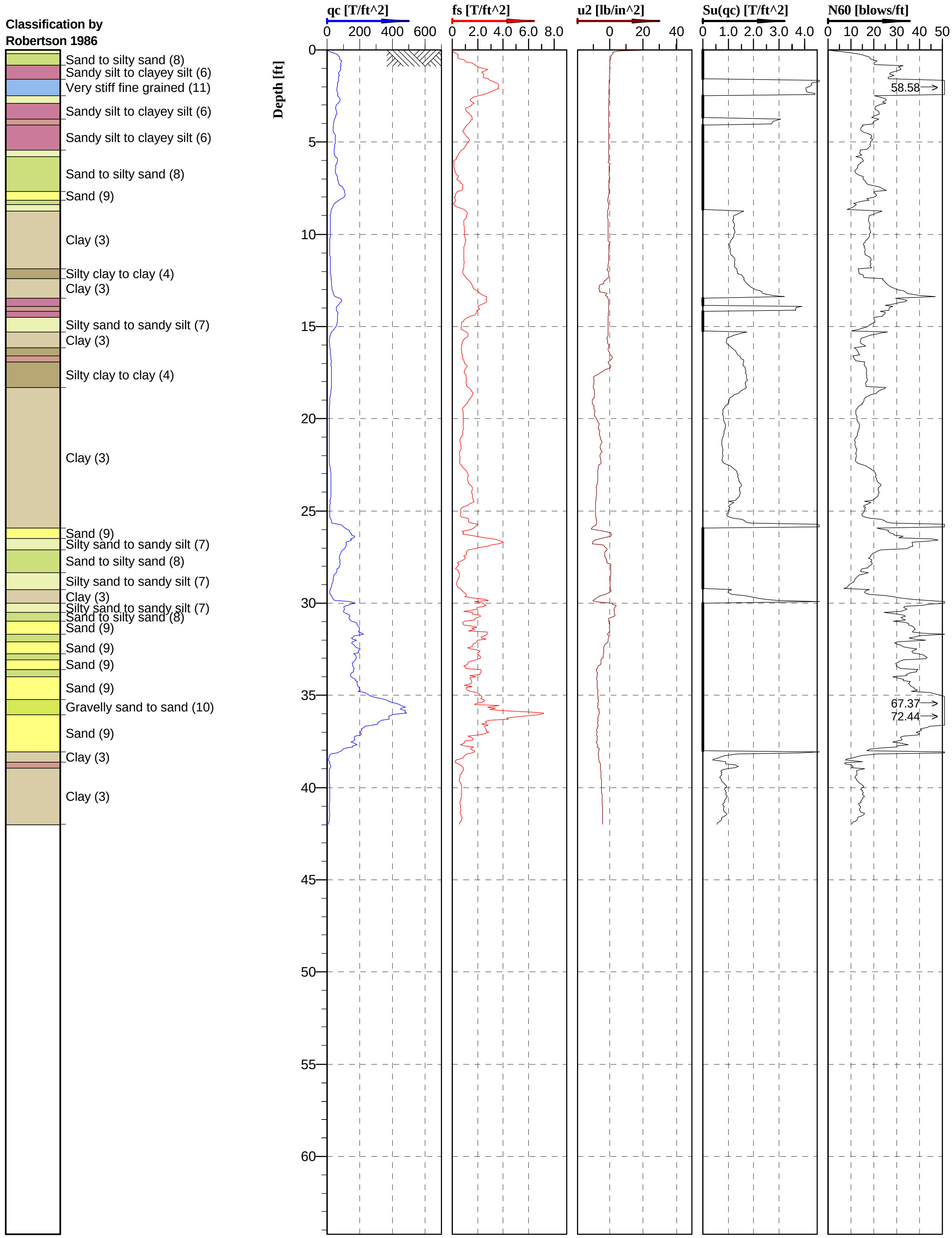
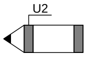


Cone No: 3789
Tip area [cm2]: 10
Sleeve area [cm2]: 150

Location: Gilroy, California	Position:	Ground level:	Test no: CPT-156_50E
Project ID: 115400	Client: GEI	Date: 12/14/2011	Scale: 1 : 90
Project: Lower Llagas Creek Capacity Restoration Project		Page: 1/1	Fig:
		File: CPT-156_50E.cpd	

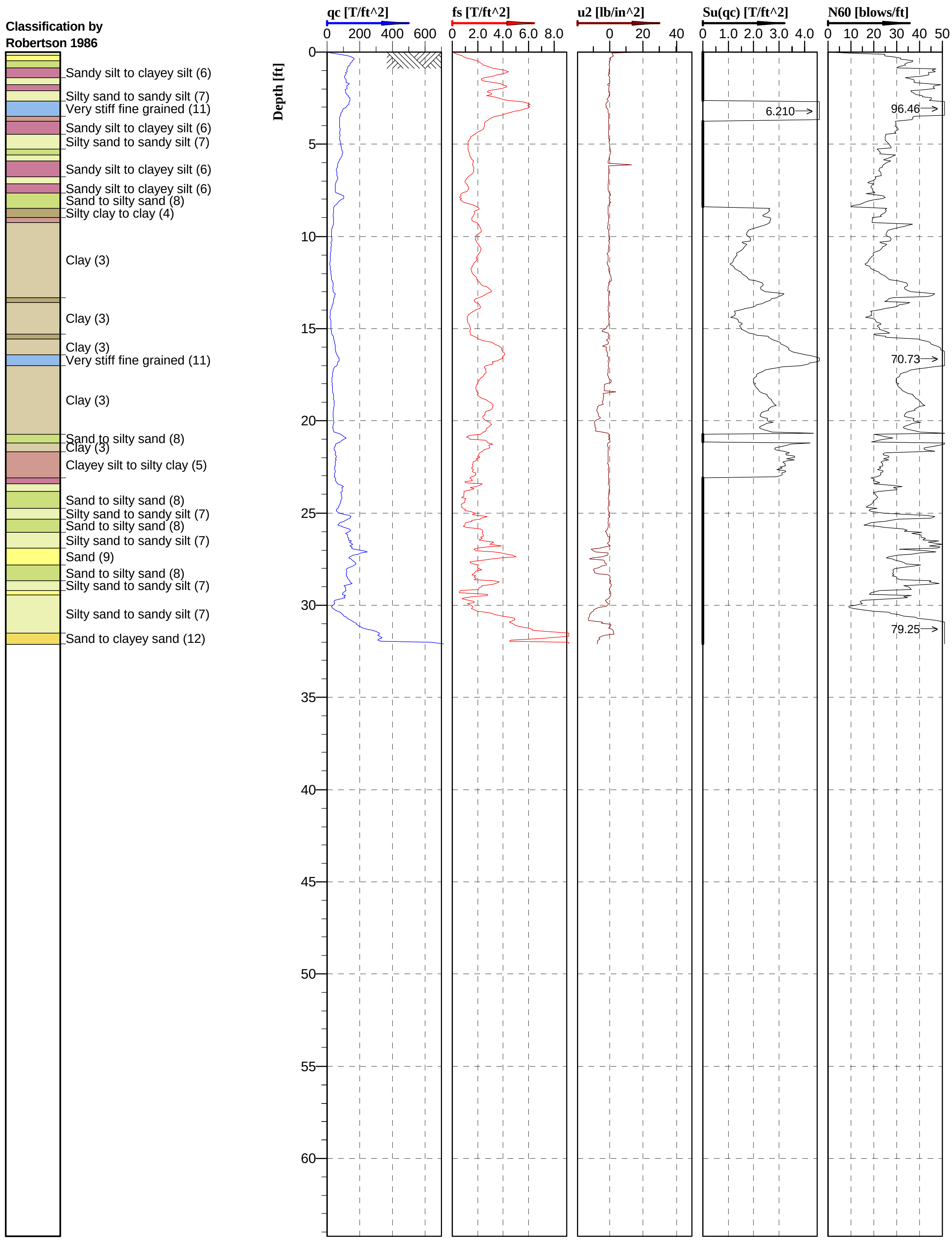


CALIFORNIA PUSH TECHNOLOGIES INCORPORATED



Cone No: 3789
Tip area [cm2]: 10
Sleeve area [cm2]: 150

Location: Gilroy, California	Position:	Ground level:	Test no: CPT-157_00W
Project ID: 115400	Client: GEI	Date: 12/15/2011	Scale: 1 : 90
Project: Lower Llagas Creek Capacity Restoration Project		Page: 1/1	Fig:
		File: CPT-157_00W.cpd	



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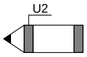
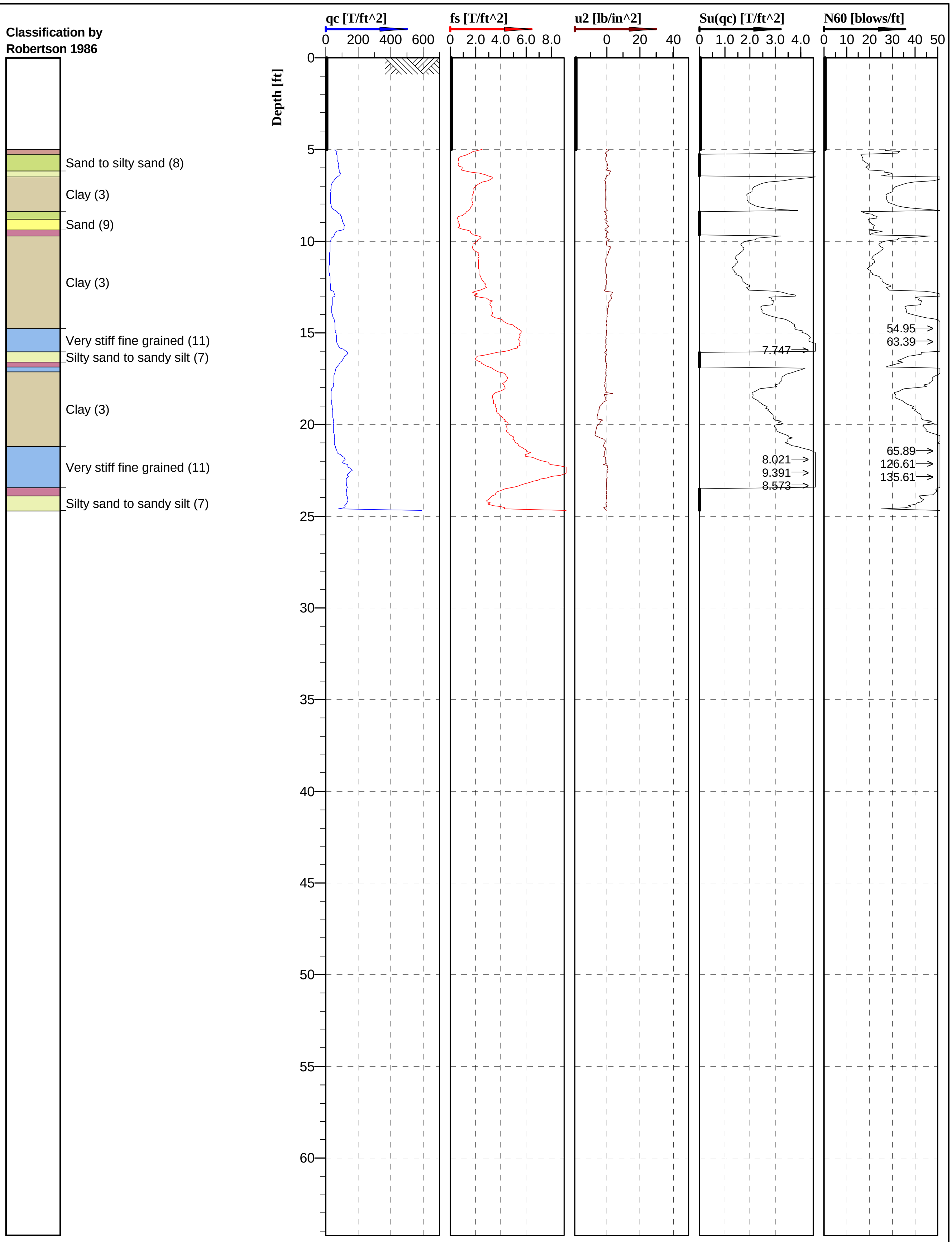
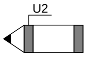


Cone No: 3789
Tip area [cm2]: 10
Sleeve area [cm2]: 150

Location: Gilroy, California	Position:	Ground level:	Test no: CPT-161_00E
Project ID: 115400	Client: GEI	Date: 12/15/2011	Scale: 1 : 90
Project: Lower Llagas Creek Capacity Restoration Project		Page: 1/1	Fig:
		File: CPT-161_00E.cpd	

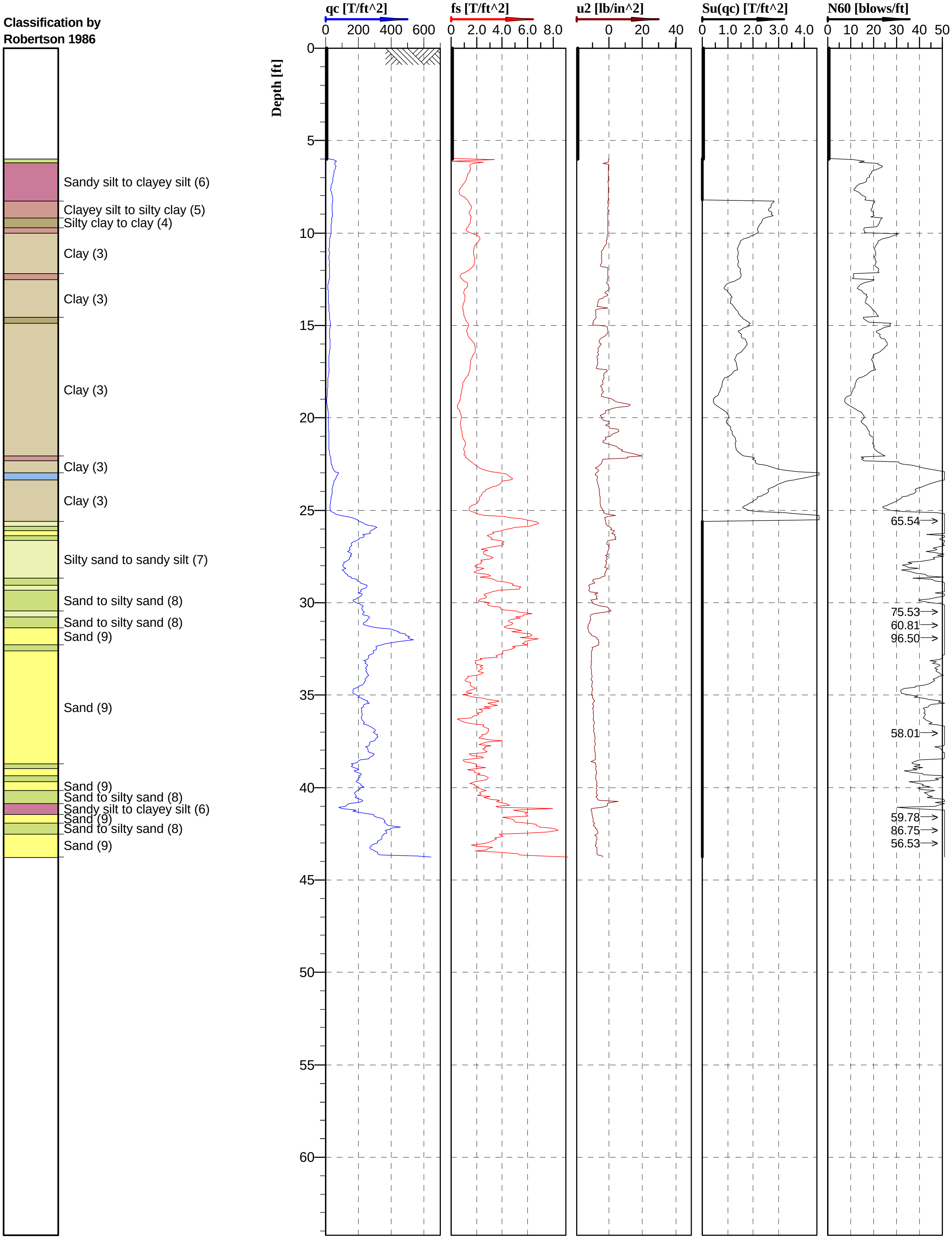


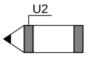
CALIFORNIA PUSH TECHNOLOGIES INCORPORATED



Cone No: 3789
Tip area [cm2]: 10
Sleeve area [cm2]: 150

Location: Gilroy, California	Position:	Ground level:	Test no: CPT-166_75W
Project ID: 115400	Client: GEI	Date: 12/19/2011	Scale: 1 : 90
Project: Lower Llagas Creek Capacity Restoration Project		Page: 1/1	Fig:
		File: CPT-166_75W.cpd	

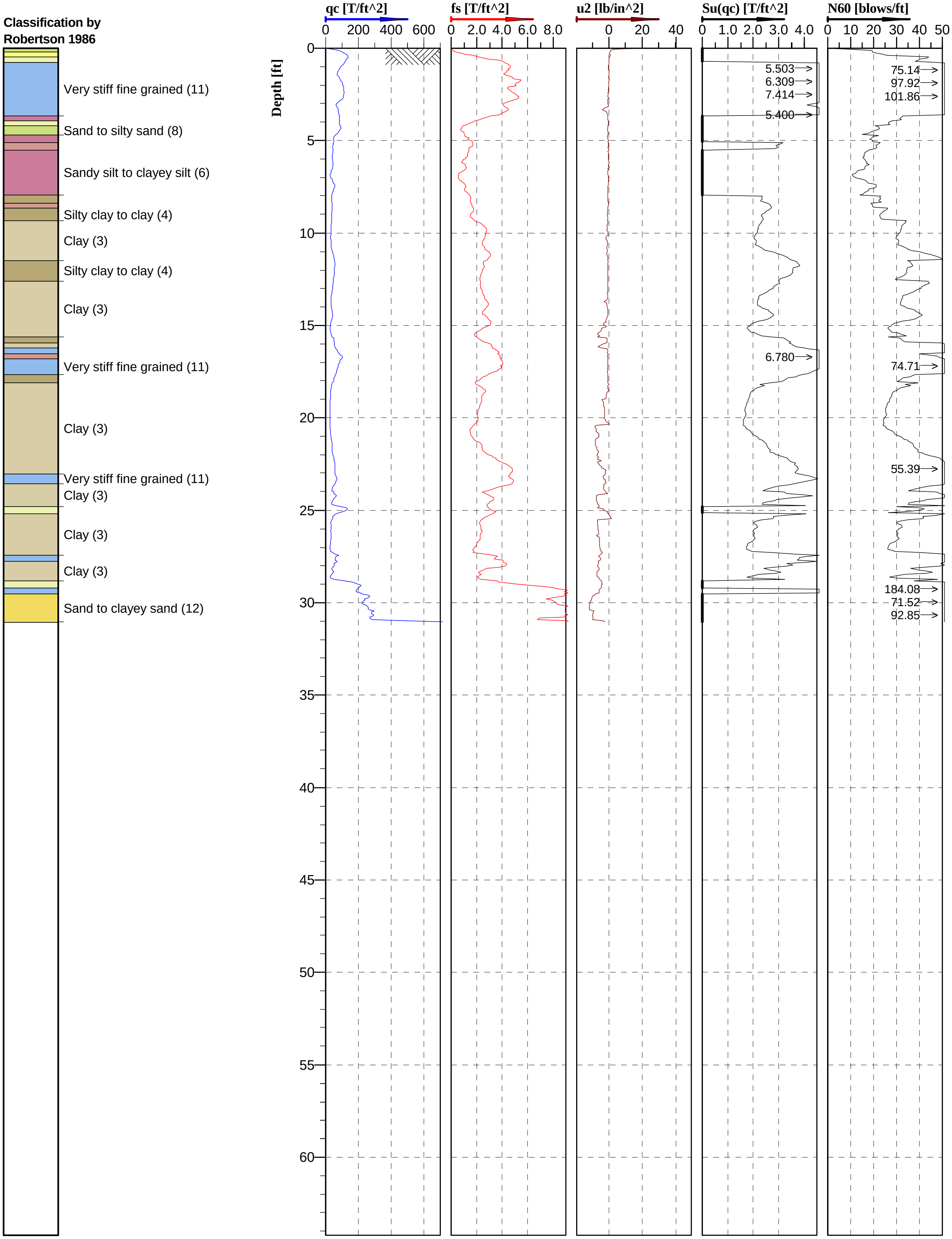




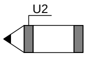
CALIFORNIA PUSH TECHNOLOGIES INCORPORATED

Cone No: 3789
Tip area [cm2]: 10
Sleeve area [cm2]: 150

Location: Gilroy, California	Position:	Ground level:	Test no: CPT-173_50W
Project ID: 115400	Client: GEI	Date: 12/15/2011	Scale: 1 : 90
Project: Lower Llagas Creek Capacity Restoration Project		Page: 1/1	Fig:
		File: CPT-173_50W.cpd	



CALIFORNIA PUSH TECHNOLOGIES INCORPORATED



Cone No: 3789
Tip area [cm2]: 10
Sleeve area [cm2]: 150

Location: Gilroy, California	Position:	Ground level:	Test no: CPT-175_00E
Project ID: 115400	Client: GEI	Date: 12/19/2011	Scale: 1 : 90
Project: Lower Llagas Creek Capacity Restoration Project		Page: 1/1	Fig:
		File: CPT-175_00E.cpd	

GEI Consultants

Client: Santa Clara Valley Water District
Project: Lower Llagas Creek Capacity Restoration Capital Project
Project No.: 11540-0

Prepared By: Matt Powers
Date: 06/18/ 2012
Checked By: Len Sansone
Date: 6/20/2012

Summary of Existing Subsurface Information

Summary of Existing Subsurface Information Considered in GEI Evaluation

As part of our scope, GEI reviewed existing project documents provided by the District, which included subsurface data and information from previous borings performed along Lower Llagas Creek within Reaches 1, 2A, and 2B. Documents reviewed containing relevant subsurface information, especially boring logs, included the following:

1. Curry, Jerald M., Geologic Report for Llagas Creek, Reach 2, Santa Clara Co., California, Davis, California, 1982.
2. Soil Conservation Service, Llagas Creek – Geologic Profile, Santa Clara County, California, 1973.
3. Soil Conservation Service, As-Built Drawings for Llagas Creek Pajaro River to 1500 Feet Upstream of Bloomfield Road, Davis, California.
4. _____, Map and Construction Plan for Lower Llagas Creek – Reach 2A from 12000' Upstream of Bloomfield Road to 8200' Upstream of Bloomfield Road (As-Built), Santa Clara County, California, 1984.
5. _____, Lower Llagas Creek Watershed, Reach 2B Construction Drawings (As-Built), Santa Clara County, California, 1985.

The subsurface data and information from these sources was used in assessing subsurface characterization and in developing subsurface profiles and analysis cross sections. The existing information and data was primarily used as supplementary to fill any data gaps between recent explorations performed by the GEI team and to confirm or refine the stratigraphy developed for each analysis cross section. Specific boring logs considered at each analysis cross section, and the coinciding reference document (as numbered above), are summarized in **Table 1** below. Scanned copies of these boring logs are provided for reference in **Attachment 1** (following). The locations of the previous borings are shown on **Figures 9** and **11-14** of the report.

TABLE 1 – Summary of Previous boring Logs used in GEI Analyses

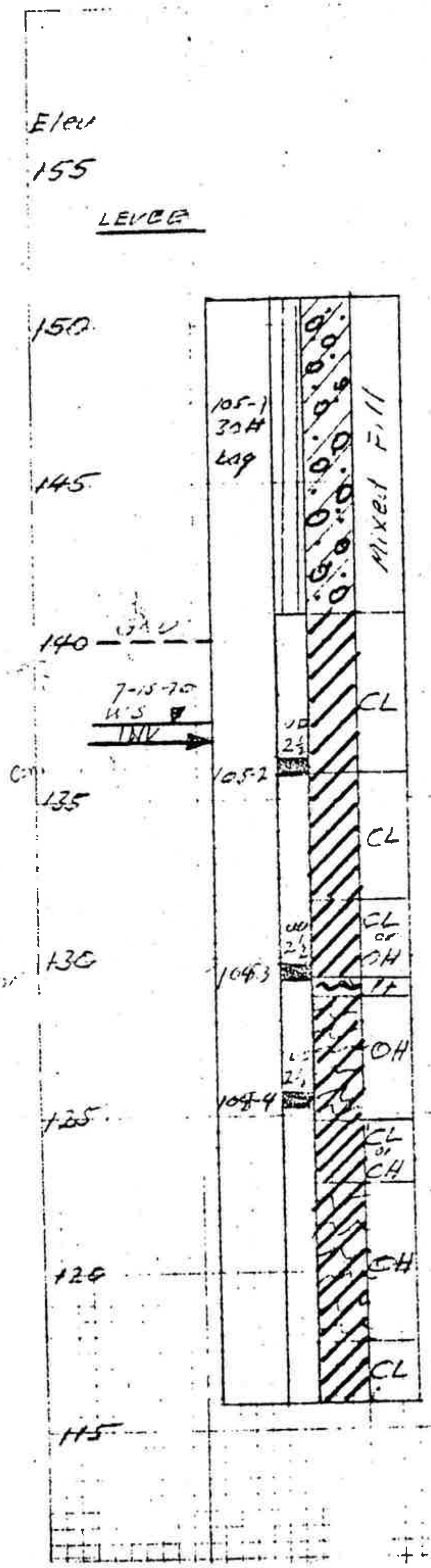
GEI Analysis Cross Section	Previous Borings Used	Reference Document
50+00	TH-105	2,3
	TH-106	2,3
78+00	TH-107	2,4
	3-77	2
	4-83	2
	5-89	2
92+50	TH-108	2,4
	6-95	2
	7-100	2
106+50	TH-109	2,4
	8-113	2
126+00	TH-111	2,4
	10-132	2
134+00	TH-112	2,4
166+50	TH-115	2,4
	14-166	2

Attachments

Attachment 1 – Previous Boring Logs by Others Considered in GEI Evaluations

ATTACHMENT 1

TH 105
7-14-70
Sta 45+00
70' W ℄



Levee material - sand, gravel, clay

CLAY silty Mottled, stiff moist
blocky, fat clay prob. carbon
decomposed vegetation, very weak
organic odor

CLAY as above color change to dar
grey with mottling med consist

CLAY lean grey, fat clay, sticky, small
mollusk shells, [illegible]
PEAT brown, fibrous, moist

CLAY organic, greenish grey interbedd
w/ pure peat

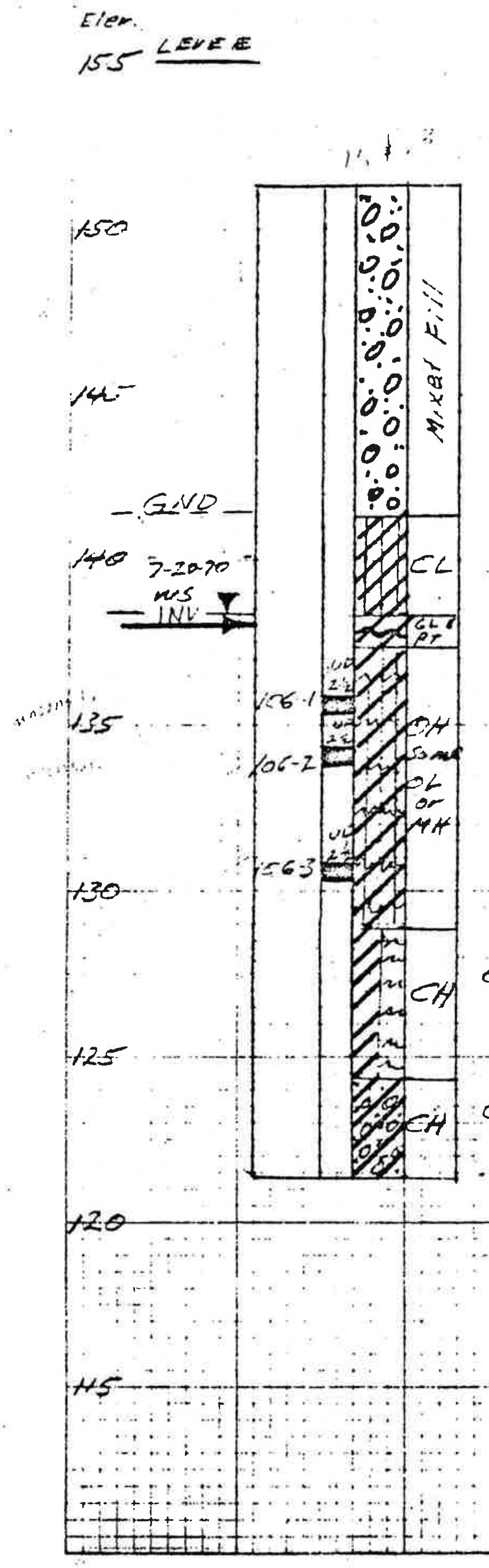
CLAY, greenish grey, stiff, very l
if any peat

CLAY, organic, peaty

CLAY very stiff, moist, black

LOWER
LLAGAS CREEK WATERSHE
LLAGAS [illegible]

TH 106
7-17-70
Sta 60+00
30' N ℄



Levee material - sand and gravel, little or no clay

CLAY, silty, brown, mottled, appears to light weight, maybe organic

CLAY & peat, black

CLAY, silty organic, blue-green, mottled rusty in places, thin < ½" carbon like layers, roots thin peat layers are leaves and twigs that are nearly completely decomposed some layers organic silts

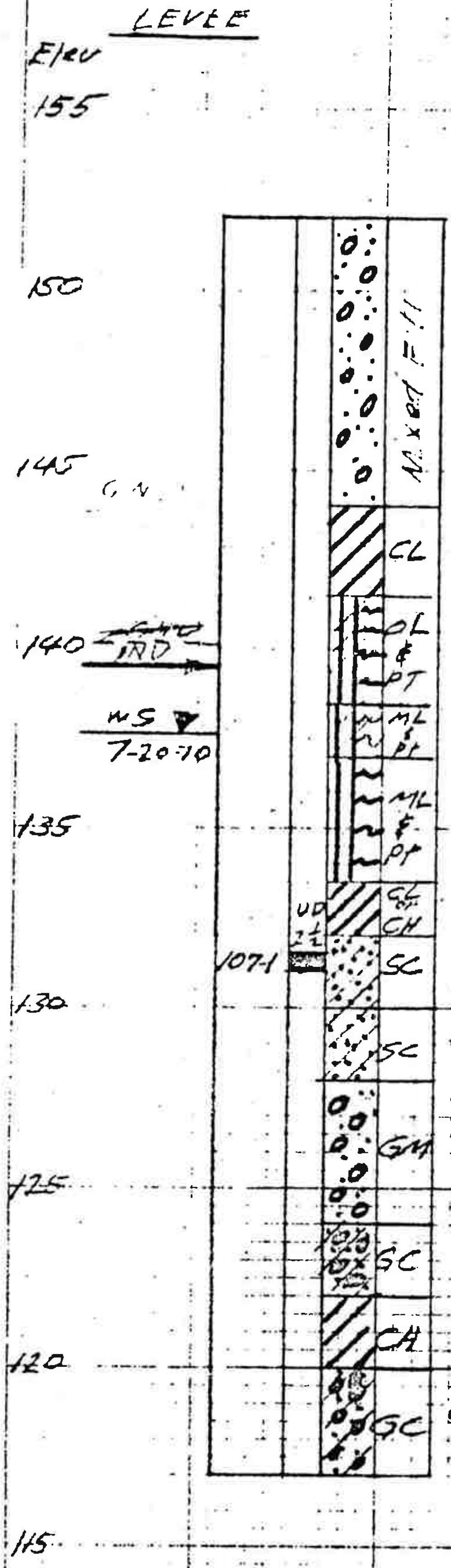
CLAY mod. stiff, blue-green, peat layers up to 1"

CLAY, sandy, blue-green, some gravel

LOWER
LLAGAS CREEK WATERSHED

LLAGAS CK Rch 2-

TH 107
7-17-70
Sta 75+00
30' E ℄



Levee material, sand, gravel and clay mixed

CLAY, mottled, grey or brown

SILT, clayey and brown and black peat, soft to v. soft some organic silt

SILT, clayey as above but stiffer w/soft minor peat blue grey

SILT & PEAT, brown & black, H_2S odor strong peat, peat is brown and fibrous in places.

CLAY, blue green, mod stiff, roots

SAND, clayey, blue-green w/roots, med grained accass. pebble to ¼", rounded

SAND, clayey as above, no roots, reddish br

GRAVEL, sandy, loose, dr. little on auger
brown

GRAVEL sandy, clayey brown

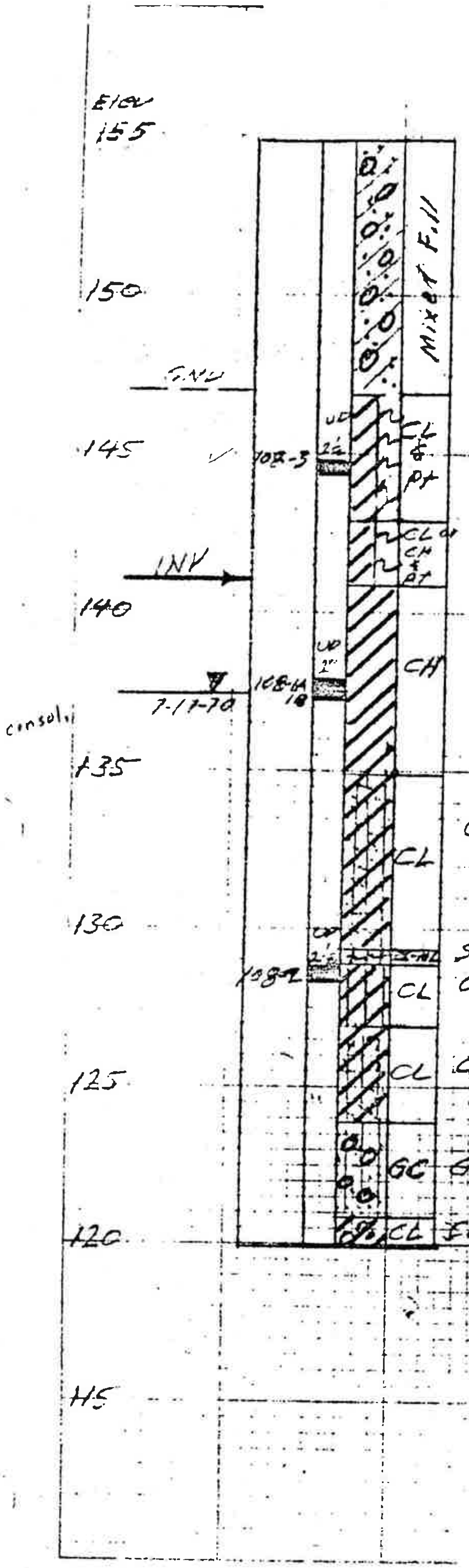
Clay, stiff, brown

GRAVEL, clayey, fine gravel of coarse sa

LOWER
LLAGAS CREEK WATERSHED
LLAGAS CK RCH L-1

TH107

TH 108
7-16-70
Sta 90+00
35' E ℄



Levee material sand, gravel sa
Clay

CLAY, dk grey black, sl. mottled, wit
peat, some mottling

CLAY, blue, stiff, thin (up to ½) peat string
peat layers soft, fluffy, try for 2" sample &

CLAY, dark bluish grey, mottled twigs & r
but these arent extensive, occass pebbl
up to ¼"

CLAY, silty, v.f. sandy, brown, rusty mottli
stiff

SILT, blue grey, mottled, organic, sl. clayey, sandy
CLAY, silty v.f. sandy, brown as above

CLAY, sandy silty, blue grey

GRAVEL - Clayey, sandy up to ½" brown saturat

CLAY - gravelly, brown

LOWER
LLAGAS CREEK WATERSHE

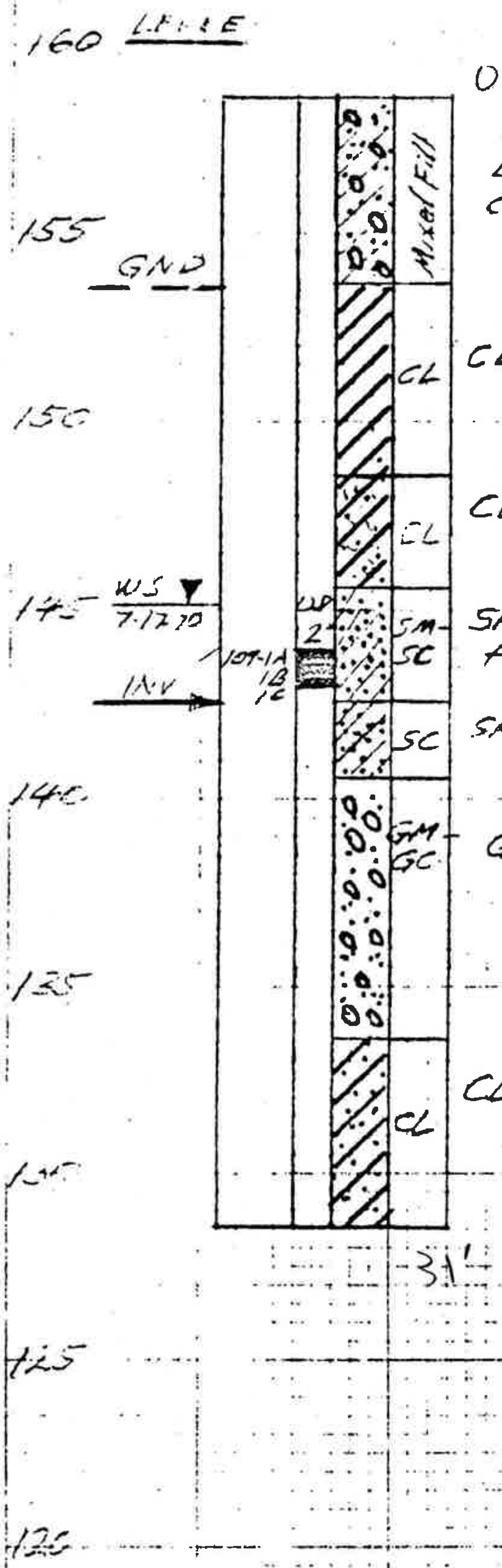
LLAGAS CK RCH L-

TH 109

7-16-70

Sta 105+00

35' E ℄



Levee material, sand, gravel (less ½") some clay

CLAY, black, med stiff to stiff

CLAY, fine sandy

SAND, fine, satur, grey, rusty mottling, pre fine, also clayey, may be enough to be SC

SAND, as above w/more clay & coarser, satur

GRAVEL, sand, satur.

CLAY sandy, stiff - med stiff, brown, satur, fine - med alternating - sm coarse sand.

LOWER
LLAGAS CREEK WATERSHED

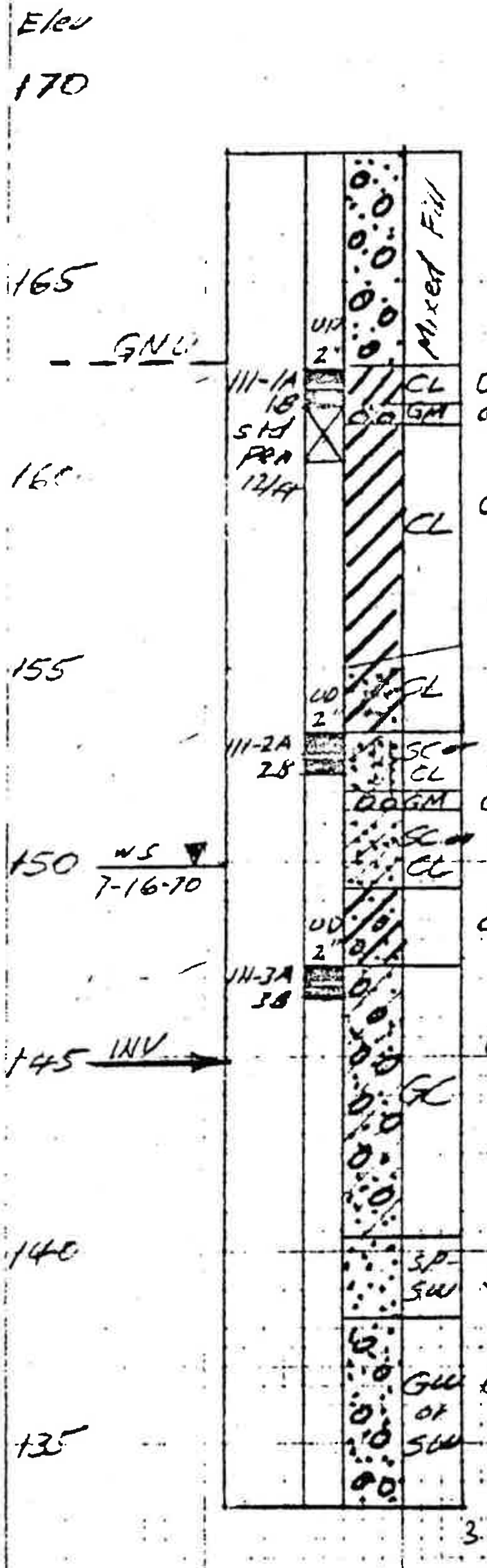
LLAGAS CR [illegible]

TH 111

7-15-70

Sta 128+00

45' E ℄



Levee material, gravel & sand
dry to damp

CLAY, black mottled, moist

GRAVEL-sandy silty brown up to 1"

CLAY, dk grey to black mottling increase
w/depth

CLAY ~~w/~~ increasing fine sand, reddish
brown mottling, then to clayey sand

SAND, fine, silty & clayey, some gravel,

GRAVEL, sandy, a little silt, brown, moist, loose

sand as above or clay fine sandy brown

Clay, sandy, gravelly, brown, stiff, sa tu

GRAVEL, sandy, clayey, grey, satur to 1
angular, some round

SAND, med grained, brown soft drilling

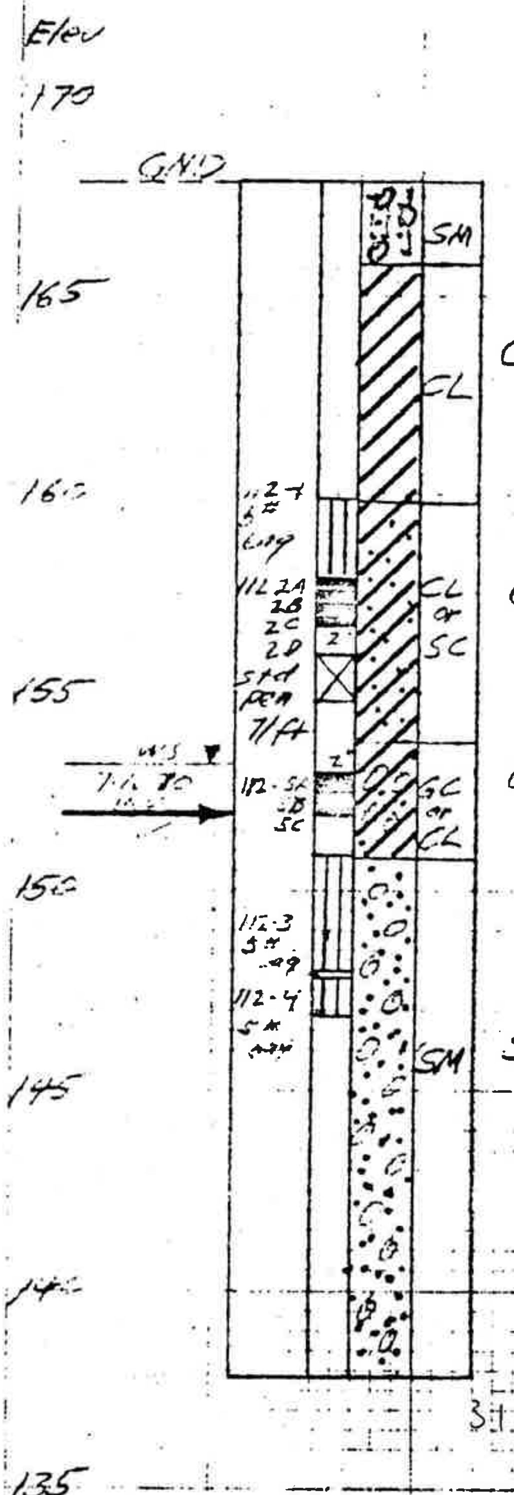
GRAVEL, up to 2" & sand, no recovery
on auger

LOWER
LLAGAS CREEK WATERSHED

LLAGAS CR [illegible]

TH 111

TH 112
7-15-70
Sta 135+00
50' E ℄



SAND, gravel, silty, brown, moist, loose

CLAY, black, mod. stiff, roots, moist, pla
Color change to about 5' mottling inc

CLAY, fine sandy, reddish brown, acc
gravel up to ½", angular, moist.

CLAY, gravelly, sandy, brown, gravel up
½"

SAND, gravelly, silty, sl. clayey, brow
water, very little comes back on
auger

LOWER
LLAGAS CREEK WATERSHED
LLAGAS CR. REACH 2-1

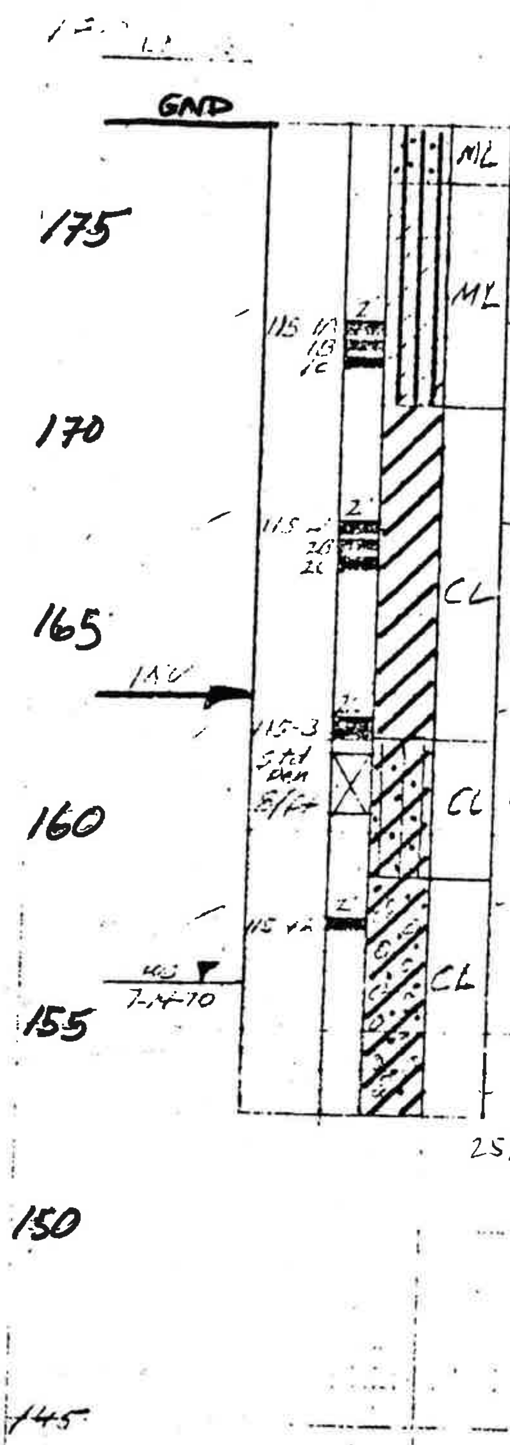
TH 112

TH 115

7-13-70

STA 15+00

℄



SILT, brown, fine sandy, clayey

SILT, brown, clayey, little or no sand

CLAY, fat, stiff, moist, black

CLAY, v. silty, brown, moist, sandy, stiffer
w/ depth

CLAY, fine gravelly & sandy, fine-med
gravel up to 1"

LOWER
LLAGAS CREEK WATERSHED

LLAGAS CREEK REACH L-1

TH 115

6

U. S. DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE

LOG OF TEST HOLES

SCS-533T
REV. 2-64

WATERSHED: Lower Llagas Creek
SUB-WATERSHED: Unit L-1
SITE NO.:
LOCATION: Morgan Hill, CA
OWNER:
STATE:
LOGGED BY: C. E. Stearns
DATE: 4/10/73
PROJECT: WP-07 ____ WP-08 x FP-03 ____ P.L.-46 ____
DRILLING EQUIPMENT: Failing w/Pitcher Tube 4" I.D.
LOCATION OF HOLES: West Side Channel-toe of levee

HOLE NO.	STA. & SURFACE ELEVATION	HOLE DEPTH FROM FT.	HOLE DEPTH TO FT.	DESCRIPTION OF MATERIALS	N	USCS	TYPE BIT USED	SAMPLES NO.	SAMPLES TYPE [1]	SAMPLES FROM FT.	SAMPLES TO FT.	CSE. %	REM. [2] MIN. DIAM.	REC. [3] %
1-66	66+00 142.0	0	4	Invert 136.7 Clay, dark greyish-brown, peaty, damp, Sample started @ 4.0'		CL								
		4	6.5	As above - 3" peat layer @ 6.2' too much disturbance-will push tube only Push @ 4'	6	Cb Pt	PB*							
		4	5.3	Clay and peat in alternating layers	6	CL Pt	PB	1	Ud	4	5.3			100
2-71	143.0 71+00	0	7.9	Invert 137.0 Dark grey clay and peat	6	CL Pt	PB	1	UD	5.7	6.7			100
				Note: 2-71-2 is nearly all peat, some clay 2-71-1 is mostly clay, bluish-grey				2	Ud	6.7	7.9			100
3.77	143.6 77+00	0	7	Invert 137.8 Dark grey, clay and peat exactly like previous hole at 71+00 - Sample pulled out of tube Water level at 3.0' below surf or 140.6	6	CL Pt	PB							

1. DISTURBED-UNDISTURBED-ROCK CORE 2. COARSE MATERIAL REMOVED 3. PERCENT SAMPLE RECOVERY

*PB = Pitcher Barrel S = Shelby (Pushed)

SHEET 1 OF 2 SHEETS

U. S. DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE

LOG OF TEST HOLES

SCS-533T
REV. 2-64

WATERSHED Lower Llagas
SUB-WATERSHED Unit L-1
SITE NO.
LOCATION Morgan Hill, CA
OWNER
STATE
LOGGED BY C. E. Stearns
DATE 4/11/73
PROJECT: WP-07 ____ WP-08 x FP-03 ____ P.L.-46 ____
DRILLING EQUIPMENT Failing w/Pitcher Barrel 4" I.D.
LOCATION OF HOLES West Bank Channel

HOLE NO.	STA. & SURFACE ELEVATION	HOLE DEPTH FROM FT.	HOLE DEPTH TO FT.	DESCRIPTION OF MATERIALS	N	USCS	TYPE BIT USED	SAMPLES NO.	SAMPLES TYPE 1	SAMPLES FROM FT.	SAMPLES TO FT.	SAMPLES CSE. %	SAMPLES REM. 2 MIN. DIAM	SAMPLES REC. 3 %
4-83	144.5			Invert 138.2										
	83+00	0	7.9	Dark grey High plastic clay and silt with interbedded peat		CH	PB*	1	Ud	5.7	6.9			100
				Note: Sample representative of reach 71+00 & 83+00										
5-89	146.2			Invert 138.7										
	89+00	0	7.6	Dark grey clay, and some peat		CH	PB	1	Ud	6.0	7.3			100
		7.0	9.6	" " " v. stiff, stringer of twigs or roots, but no peat layers		CH	PB	2	Ud	8.6	9.6			100
6.95	148.6			Invert 139.0										
	95+00	0	10	Black clay, high plastic, very stiff, weathered rock fragments. No water in hole		CH	PB	1	Ud	8.7	9.7			100
		10	11	Clay, silty sandy, reddish brown		CL	PB	2	Ud	9.7	11.0			100
				Note: Both samples broke about in middle										
				Sample @ 6.7' to test representative sample of stiff black clay. Water @ 8.5' seeping in hole.		CH	PB	3	Ud	6	7			100

1. DISTURBED-UNDISTURBED-ROCK CORE 2. COARSE MATERIAL REMOVED *PB = Pitcher Barrel 3. PERCENT SAMPLE RECOVERY

SHEET 2 OF 5 SHEETS

U. S. DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE

LOG OF TEST HOLES

SCS-533T
REV. 2-64

WATERSHED Lower Llagas
SUB-WATERSHED Unit L-1
SITE NO.
LOCATION Morgan Hill, CA
OWNER
STATE
LOGGED BY C.E. Stearn
DATE 4/11/73
PROJECT: WP-07 ____ WP-08 _x_ FP-03 ____ P.L.-46 ____
DRILLING EQUIPMENT Failing w/Pitcher Barrel 4" I.D.
LOCATION OF HOLES West Bank

HOLE NO.	STA. & SURFACE ELEVATION	HOLE DEPTH FROM FT.	HOLE DEPTH TO FT.	DESCRIPTION OF MATERIALS	N	USCS	TYPE BIT USED	SAMPLES NO.	SAMPLES TYPE[1]	SAMPLES FROM FT.	SAMPLES TO FT.	CSE. %	REM.[2] MIN. DIAM.	REC.[3] %
7-100	150.5			Invert 139.3										
	100+00	0	6	Clay-grey v. stiff, sandy, mottled (rusty), moist to wet (no water though)		CH	PB	1	Ud	6	7			100
W.L.	@5.0'	7	11	Clay-grey as above, very strong rusty mottling		CH		2	Ud	10	11			100
		11	12	Sand, Clayey, saturated-greenish-grey, soft		SC		3	D	11	12			100
8-113	161.5			Inverts 139.9 - 145.5										
	113+00	0	5	Levee material as before										
		5	7	Clay, dark grey to black, stiff		CL								
		7	11	Clay, med. grey, stiff (color chg. only)		CL								
		11	13	Clay lt.-med, grey, stiff, color chg., no chg. in drilling pressure.		CL								
		13	15	Sandy silty clay, reddish-brown mottled, dense-good foundation material.		CL	PB*	1	Ud	14	15			100
							PB	2	Ud	16	17			100
		15	21.5	Gravel, sandy, up to pea-gravel size, some clay		GC								
		21.5	23	Sand, med., up to 1 mm ave, reddish-brown very little if any clay		SP	PB	3	Ud	21.5	22.5			100
		23	24	Gravel, pea-gravel, sandy, loose, very little fines		GM								
		24	25	Clay, sandy silty, stiff, reddish-brown		CL	PB	4	Ud	24	25			100
		25	26	Gravel, pea-size		GM								
		26	29	Clay as above, v. stiff. & dense, picked up foot left in hole.		CL								
			TD											

Note: Good clay zone down to 15 ft. Could keep invert in this zone. Also good zone @ 24-29 ft. *PB - Pitcher Barrel

1. DISTURBED-UNDISTURBED-ROCK CORE 2. COARSE MATERIAL REMOVED 3. PERCENT SAMPLE RECOVERY

SHEET ____ OF ____ SHEETS

U. S. DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE

LOG OF TEST HOLES

SCS-533T
REV. 2-64

WATERSHED Lower Llagas
SUB-WATERSHED Unit L-1
SITE NO.
LOCATION Morgan Hill, CA
OWNER
STATE
LOGGED BY C.E. Stearn
DATE 4/11/73
PROJECT: WP-07 ____ WP-08 X FP-03 ____ P.L.-46 ____
DRILLING EQUIPMENT Failing w/Pitcher Barrel 4" I.D.
LOCATION OF HOLES West Bank

HOLE NO.	STA. & SURFACE ELEVATION	HOLE DEPTH FROM FT.	HOLE DEPTH TO FT.	DESCRIPTION OF MATERIALS	N	USCS	TYPE BIT USED	SAMPLES NO.	SAMPLES TYPE 1	SAMPLES FROM FT.	SAMPLES TO FT.	SAMPLES CSE. %	SAMPLES REM. 2 MIN. DIAM.	REC. 3 %
* 9-124	165.3			Invert 140.5 146.5										
	124+00	0	17.5	Levee and grey clay, as in earlier holes		CH								
		17.5	20	Clay Sandy, reddish-brown, stiff, sparse gravel, mottled.		CL								
		20	23	Sand, clayey, soft, satur., blue-green		SM	SC	1	Ud	19.6	20.8			100
		23	23.7	Clay, grey-black,v. stiff, no organic matter		CH		2	Ud	23.0	23.7			100
* 10-132	166.0			Invert 140.9 or 146.5										
	132+00	0	10	Clay, black, sandy up to #4		CL								
		10	21.4	Clay, sandy, stiff, slightly harder drilling reddish-brown,		CL		1	Ud	17.9	18.7			100
				Start Pitcher @ 16.0'				2	Ud	19.8	21.0			100
		21.4	26.4 T.D.	Gravel, clayey, sandy, reddish-brown, interbedded w/relatively uniform slightly clayey sand, med. grained up to 1mm, interbedded Gravel & sand Less clay w/depth-last sample is loose pea-gravel and coarse sand.		GC		3	D	21.0	21.4			100(B
								4	D	23.7	24.7			100(B
								5	D	25.4	26.4			100(B
				* Note: Prob. should keep drop dwonst.of 128+00 to keep out of gravels between stg 128 & 147										

1. DISTURBED-UNDISTURBED-ROCK CORE 2. COARSE MATERIAL REMOVED 3. PERCENT SAMPLE RECOVERY

SHEET ____ OF ____ SHEETS

U. S. DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE

LOG OF TEST HOLES

SCS-533T
REV. 2-64

WATERSHED Lower Llagas
SUB-WATERSHED Unit L-1
SITE NO.
LOCATION Morgan Hill, CA
OWNER
STATE
LOGGED BY C.E. Stearn
DATE 4/13/73
PROJECT: WP-07 ____ WP-08 x ____ FP-03 ____ P.L.-46 ____
DRILLING EQUIPMENT Failing w/Pitcher Barrel
LOCATION OF HOLES

HOLE NO.	STA. & SURFACE ELEVATION	HOLE DEPTH FROM FT.	HOLE DEPTH TO FT.	DESCRIPTION OF MATERIALS	N	USCS	TYPE BIT USED	SAMPLES NO.	SAMPLES TYPE[1]	SAMPLES FROM FT.	SAMPLES TO FT.	SAMPLES CSE. %	SAMPLES REM.[2] MIN. DIAM.	SAMPLES REC.[3] %
13-157	174.3			Invert @ 20'										
	157+00	0	13	Profile as in previous hole-Cuttings are black clay		CL		1	Ud	14.7	15.7			100
		13	15.8	Clay, black, stiff, some fractures that affect strength.		CL								
		15.8	17.4	Sand, Loose, brown, drill washed most away some gravel and sand		SP								
		17.4	21.1	Clay, reddish-brown, stiff, some gravels		CL		2	Ud	20.4	21.1			100
			T.D.	Note: may be damaged (#2) so run classification at least.										
14-166	176.8			Invert 154.3 & 164										
	166+00	0	10.5	Dark brown to grey clay as in previous hole #115		CH	PB	1	Ud	10	10.5			100
	contact	10.5	12.4	Black clay, sandy and gravelly, stiff,		CL								
		12.4	15.5	Sand, gravelly, clayey, v. dense, and hard, reddish-brown, Clean hole to 16.2'.		SC		2	D	12.4	13.4			
	contact	15.5	16.2	Clay reddish-brown, sandy		CL								
		16.2	18	Gravel, up to 1/2", loose, lost water while drilling		GW								
gravel	lense	contact		showing gravel is open & permeable.										
		18	22	Clay, sandy, reddish-brown, v. stiff		CL		3	Ud	18.2	19			100
		22	24.5	Clay, gravelly, sandy, up to 1", reddish-brown		CL		4	Ud	20.2	21.2			100
			T.D.	v. stiff				5	D	22	24.5			100

1. DISTURBED-UNDISTURBED-ROCK CORE 2. COARSE MATERIAL REMOVED 3. PERCENT SAMPLE RECOVERY

SHEET ____ OF ____ SHEETS

Appendix C

Geotechnical and Environmental Laboratory Testing Results

Moisture-Density-Porosity Report
Cooper Testing Labs, Inc. (ASTM D 2937)

CTL Job No: 250-049a
Project No. 115400
By: RU
Client: GEI Consultants
Date: 02/23/12
Project Name: Lower Llagas Creek
Remarks:

Boring:	B-166+50E	B-166+50E	B-166+50E	B-166+50E	B-173+50W	B-173+50W	B-173+50W	B-173+50W
Sample:	1		7		4	10	14	
Depth, ft:	2	6.5	13	35	6	16	25	34
Visual Description:	Dark Brown Sandy CLAY	Olive Brown Silty SAND	Black Sandy CLAY	Olive Brown Well-Graded SAND w/ Silt & Gravel	Dark Brown Silty SAND	Olive Brown Sandy CLAY	Brown Poorly Graded SAND w/ Clay & Gravel	Olive Brown Well-Graded SAND w/ Gravel
Actual G_s								
Assumed G_s	2.70		2.70		2.70	2.70	2.70	
Moisture, %	11.8	13.9	25.4	13.3	9.2	19.7	13.0	13.3
Wet Unit wt, pcf	114.5		110.7		94.2	126.0	133.3	
Dry Unit wt, pcf	102.4		88.2		86.3	105.3	117.9	
Dry Bulk Dens.pb, (g/cc)	1.64		1.41		1.38	1.69	1.89	
Saturation, %	49.4		75.3		26.0	88.2	81.8	
Total Porosity, %	39.3		47.7		48.9	37.6	30.1	
Volumetric Water Cont,Θw	19.4		35.9		12.7	33.2	24.6	
Volumetric Air Cont., Θa	19.9		11.8		36.1	4.4	5.5	
Void Ratio	0.65		0.91		0.96	0.60	0.43	
Series	1	2	3	4	5	6	7	8

Note: All reported parameters are from the as-received sample condition unless otherwise noted. If an assumed specific gravity (Gs) was used then the saturation, porosities, and void ratio should be considered approximate.

The Zero Air-Voids curves represent the dry density at 100% saturation for each value of specific gravity

Moisture-Density-Porosity Report
Cooper Testing Labs, Inc. (ASTM D 2937)

CTL Job No: 250-049b
Project No. 115400
By: RU
Client: GEI Consultants
Date: 02/23/12
Project Name: Lower Lllagas Creek
Remarks: B-141+00W;3 @ 5.5' - sample disturbed;m/c only.

Boring:	B-148+00E	B-148+00E	B-148+00E	B-141+00W	B-141+00W	B-141+00W	B-141+00W	B-141+00W
Sample:	2		12	1	2	3	6	13
Depth, ft:	0.5-2	11	30	2	2.5	5.5	10.5	24
Visual Description:	Brown Sandy CLAY	Very Dark Brown CLAY w/ Sand	Yellowish Brown Poorly Graded GRAVEL w/ Clay & Sand	Dark Brown Sandy CLAY	Brown Clayey SAND w/ Gravel	Olive Brown Silty SAND	Olive Brown Lean CLAY w/ Sand	Olive Brown Poorly Graded SAND w/ Clay & Gravel
Actual G_s								
Assumed G_s		2.70		2.70			2.70	
Moisture, %	14.3	26.5	9.6	10.5	5.8	5.9	24.3	13.4
Wet Unit wt, pcf		120.9		124.2			125.0	
Dry Unit wt, pcf		95.5		112.4			100.6	
Dry Bulk Dens.pb, (g/cc)		1.53		1.80			1.61	
Saturation, %		93.5		56.5			96.8	
Total Porosity, %		43.4		33.4			40.4	
Volumetric Water Cont,Θw		40.5		18.9			39.1	
Volumetric Air Cont., Θa		2.8		14.5			1.3	
Void Ratio		0.77		0.50			0.68	
Series	1	2	3	4	5	6	7	8

Note: All reported parameters are from the as-received sample condition unless otherwise noted. If an assumed specific gravity (Gs) was used then the saturation, porosities, and void ratio should be considered approximate.

The Zero Air-Voids curves represent the dry density at 100% saturation for each value of specific gravity

Moisture-Density-Porosity Report

Cooper Testing Labs, Inc. (ASTM D 2937)

CTL Job No:	250-049c	**Project No.**	115400	**By:**	RU
Client:	GEI Consultants	**Date:**	02/23/12		
Project Name:	Lower Llagas Creek	**Remarks:**	B-132+50E;13 @ 29.5' - sample disturbed;m/c only.		

Boring:	B-141+00W	B-132+50E	B-132+50E	B-132+50E	B-132+50E	B-132+00W	B-132+00W	B-132+00W
Sample:	14			13	16	5	8	
Depth, ft:	29.5	3	16	29.5	39	11	16	25
Visual Description:	Olive Brown Poorly Graded GRAVEL w/ Clay & Gravel	Black CLAY w/ Sand	Brown Sandy CLAY	Olive Brown Poorly Graded SAND w/ Clay & Gravel	Olive Brown Well-Graded SAND	Dark Brown Sandy CLAY	Brown Sandy CLAY	Olive Brown Poorly Graded SAND w/ Clay & Gravel
Actual G_s								
Assumed G_s	2.75	2.70	2.70			2.70	2.70	2.70
Moisture, %	10.4	20.4	23.3	17.5	14.8	25.1	17.9	13.8
Wet Unit wt, pcf	146.5	128.8	125.5			120.3	116.6	129.3
Dry Unit wt, pcf	132.7	107.0	101.8			96.2	98.9	113.6
Dry Bulk Dens.ρb, (g/cc)	2.13	1.71	1.63			1.54	1.58	1.82
Saturation, %	97.1	95.6	95.7			89.7	68.5	77.0
Total Porosity, %	22.7	36.6	39.7			43.0	41.4	32.7
Volumetric Water Cont,Θ_w	22.1	35.0	38.0			38.6	28.3	25.2
Volumetric Air Cont., Θ_a	0.7	1.6	1.7			4.4	13.0	7.5
Void Ratio	0.29	0.58	0.66			0.75	0.71	0.49
Series	1	2	3	4	5	6	7	8

Note: All reported parameters are from the as-received sample condition unless otherwise noted. If an assumed specific gravity (Gs) was used then the saturation, porosities, and void ratio should be considered approximate.

The Zero Air-Voids curves represent the dry density at 100% saturation for each value of specific gravity

Moisture-Density-Porosity Report
Cooper Testing Labs, Inc. (ASTM D 2937)

CTL Job No: 250-049d
Project No. 115400
By: RU
Client: GEI Consultants
Date: 02/24/12
Project Name: Lower Llagas Creek
Remarks:

Boring:	B-132+00W	B-127+00W	B-127+00W	B-127+00W	B-127+00W	B-116+50E	B-116+50E	B-107+00W
Sample:	16	8	9	10	11	9	14	10
Depth, ft:	34	17	20	25	29-30.5	16	30	20
Visual Description:	Olive Brown Poorly Graded SAND	Brown CLAY w/ Sand	Brown Sandy CLAY	Olive Brown Clayey GRAVEL w/ Sand	Olive Brown Well-Graded SAND w/ Clay	Mottled Greenish Gray CLAY	Mottled Olive Brown CLAY	Mottled Greenish Gray Clayey SAND
Actual G_s								
Assumed G_s		2.80	2.80	2.80		2.70	2.70	2.80
Moisture, %	17.1	25.6	30.8	11.0	16.5	17.9	24.7	21.6
Wet Unit wt, pcf		127.7	122.0	148.1		131.8	126.1	132.2
Dry Unit wt, pcf		101.7	93.3	133.4		111.8	101.1	108.7
Dry Bulk Dens.pb, (g/cc)		1.63	1.49	2.14		1.79	1.62	1.74
Saturation, %		99.6	98.5	98.9		94.9	99.8	99.4
Total Porosity, %		41.9	46.7	23.7		33.7	40.1	37.8
Volumetric Water Cont,Θw		41.7	46.0	23.5		32.0	40.0	37.6
Volumetric Air Cont., Θa		0.2	0.7	0.3		1.7	0.1	0.2
Void Ratio		0.72	0.88	0.31		0.51	0.67	0.61
Series	1	2	3	4	5	6	7	8

Note: All reported parameters are from the as-received sample condition unless otherwise noted. If an assumed specific gravity (Gs) was used then the saturation, porosities, and void ratio should be considered approximate.

The Zero Air-Voids curves represent the dry density at 100% saturation for each value of specific gravity

COOPER
TESTING LABORATORY

Moisture-Density-Porosity Report
Cooper Testing Labs, Inc. (ASTM D 2937)

CTL Job No: 250-049e
Project No. 115400
By: RU
Client: GEI Consultants
Date: 02/24/12
Project Name: Lower Llagas Creek
Remarks:

Boring:	B-107+00W	B-107+00W	B-92+50E	B-92+50E	B-92+50E	B-92+50E	B-92+50W	B-78+00W
Sample:	12	14		6	12		14	17
Depth, ft:	24	30	8	15-16.5	41	3-5	30	29
Visual Description:	Olive Brown Well-Graded SAND w/ Clay & Gravel	Yellowish Brown CLAY w/ Sand	Dark Greenish Gray Clayey SAND	Olive Lean CLAY w/ Sand	Mottled Olive Brown Sandy CLAY	Brownish Black CLAY w/ organics	Olive Brown Well-Graded SAND w/ Clay & Gravel	Bluish Gray Clayey SAND
Actual G_s								
Assumed G_s		2.75	2.70		2.80	2.70	2.70	
Moisture, %	11.2	21.7	15.0	29.2	22.5	105.3	12.1	24.1
Wet Unit wt, pcf		130.3	134.0		131.2	79.8	135.9	
Dry Unit wt, pcf		107.1	116.6		107.1	38.9	121.2	
Dry Bulk Dens.pb, (g/cc)		1.72	1.87		1.72	0.62	1.94	
Saturation, %		98.7	90.5		99.4	85.2	83.6	
Total Porosity, %		37.7	30.9		38.8	76.9	28.2	
Volumetric Water Cont,Θw		37.2	28.0		38.6	65.5	23.6	
Volumetric Air Cont., Θa		0.5	2.9		0.2	11.4	4.6	
Void Ratio		0.60	0.45		0.63	3.34	0.39	
Series	1	2	3	4	5	6	7	8

Note: All reported parameters are from the as-received sample condition unless otherwise noted. If an assumed specific gravity (Gs) was used then the saturation, porosities, and void ratio should be considered approximate.

The Zero Air-Voids curves represent the dry density at 100% saturation for each value of specific gravity

COOPER
TESTING LABORATORY

Moisture-Density-Porosity Report
Cooper Testing Labs, Inc. (ASTM D 2937)

CTL Job No: 250-049f
Project No. 115400
By: RU
Client: GEI Consultants
Date: 02/24/12
Project Name: Lower Llagas Creek
Remarks:

Boring:	B-78+00W	B-78+00W	B-65+00E	B-65+00E	B-65+00E	B-59+00W	B-59+00W	B-50+00W
Sample:	19		6	15	20	12	17	13
Depth, ft:	39	50	8.5	31	45.5	25	44	23
Visual Description:	Olive Brown Well-Graded SAND w/ Clay & Gravel	Olive Brown Sandy CLAY	Black Sandy Fat CLAY	Bluish Black CLAY w/ Sand	Bluish Black Well-Graded GRAVEL w/ Sand	Bluish Black Sandy Fat CLAY	Olive Brown Poorly Graded SAND w/ Clay & Gravel	Brownish Black PEAT
Actual G$_s$								
Assumed G$_s$		2.80	2.70	2.75	2.70	2.80		2.70
Moisture, %	10.8	25.0	13.0	25.3	10.2	43.5	10.6	252.9
Wet Unit wt, pcf		128.0	121.5	125.7	140.2	113.0		70.8
Dry Unit wt, pcf		102.4	107.5	100.3	127.2	78.7		20.1
Dry Bulk Dens.pb, (g/cc)		1.64	1.72	1.61	2.04	1.26		0.32
Saturation, %		98.7	61.9	97.6	84.4	99.7		92.2
Total Porosity, %		41.5	36.3	41.6	24.6	55.0		88.1
Volumetric Water Cont,Ɵw		40.9	22.4	40.6	20.8	54.8		81.2
Volumetric Air Cont., Ɵa		0.5	13.8	1.0	3.8	0.2		6.9
Void Ratio		0.71	0.57	0.71	0.33	1.22		7.40
Series	1	2	3	4	5	6	7	8

Note: All reported parameters are from the as-received sample condition unless otherwise noted. If an assumed specific gravity (Gs) was used then the saturation, porosities, and void ratio should be considered approximate.

The Zero Air-Voids curves represent the dry density at 100% saturation for each value of specific gravity

Moisture-Density-Porosity Report

Cooper Testing Labs, Inc. (ASTM D 2937)

CTL Job No: 250-049g **Project No.** 115400 **By:** RU

Client: GEI Consultants **Date:** 02/24/12

Project Name: Lower Llagas Creek **Remarks:**

Boring:	B-50+00W							
Sample:	22							
Depth, ft:	49							
Visual Description:	Dark Brown Poorly Graded SAND							
Actual G_s								
Assumed G_s								
Moisture, %	18.4							
Wet Unit wt, pcf								
Dry Unit wt, pcf								
Dry Bulk Dens.pb, (g/cc)								
Saturation, %								
Total Porosity, %								
Volumetric Water Cont,Өw								
Volumetric Air Cont., Өa								
Void Ratio								
Series	1	2	3	4	5	6	7	8

Note: All reported parameters are from the as-received sample condition unless otherwise noted. If an assumed specific gravity (Gs) was used then the saturation, porosities, and void ratio should be considered approximate.

The Zero Air-Voids curves represent the dry density at 100% saturation for each value of specific gravity

COOPER
TESTING LABORATORY

#200 Sieve Wash Analysis
ASTM D 1140

Job No.: 250-049
Client: GEI Consultants
Project: Lower Llagas Creek
Project No.: 115400
Date: 2/24/2012
Run By: MD
Checked By: DC

Boring:	B-166+50E	B-148+00E	B-141+00W	B-132+50E	B-132+00W	B-92+50W		
Sample:	1	2	1		8	16		
Depth, ft.:	2	0.5-2	2	16	16	24-26		
Soil Type:	Dark Brown Sandy CLAY	Brown Sandy CLAY	Dark Brown Sandy CLAY	Brown Sandy CLAY	Brown Sandy CLAY	Dark Olive Brown Clayey SAND		
Wt of Dish & Dry Soil, gm	637.0	630.1	699.6	565.5	574.0	743.1		
Weight of Dish, gm	337.6	316.3	247.8	308.3	312.9	155.9		
Weight of Dry Soil, gm	299.5	313.8	451.8	257.2	261.1	587.2		
Wt. Ret. on #4 Sieve, gm	21.6	2.8	16.8	0.0	0.8	52.5		
Wt. Ret. on #200 Sieve, gm	129.4	124.4	209.7	94.3	119.1	325.8		
% Gravel	**7.2**	**0.9**	**3.7**	**0.0**	**0.3**	**8.9**		
% Sand	**36.0**	**38.7**	**42.7**	**36.7**	**45.3**	**46.5**		
% Silt & Clay	**56.8**	**60.4**	**53.6**	**63.3**	**54.4**	**44.5**		

Remarks: As an added benefit to our clients, the gravel fraction may be included in this report. Whether or not it is included is dependent upon both the technician's time available and if there is a significant enough amount of gravel. The gravel is always included in the percent retained on the #200 sieve but may not be weighed separately to determine the percentage, especially if there is only a trace amount, (5% or less).

COOPER TESTING LABORATORY

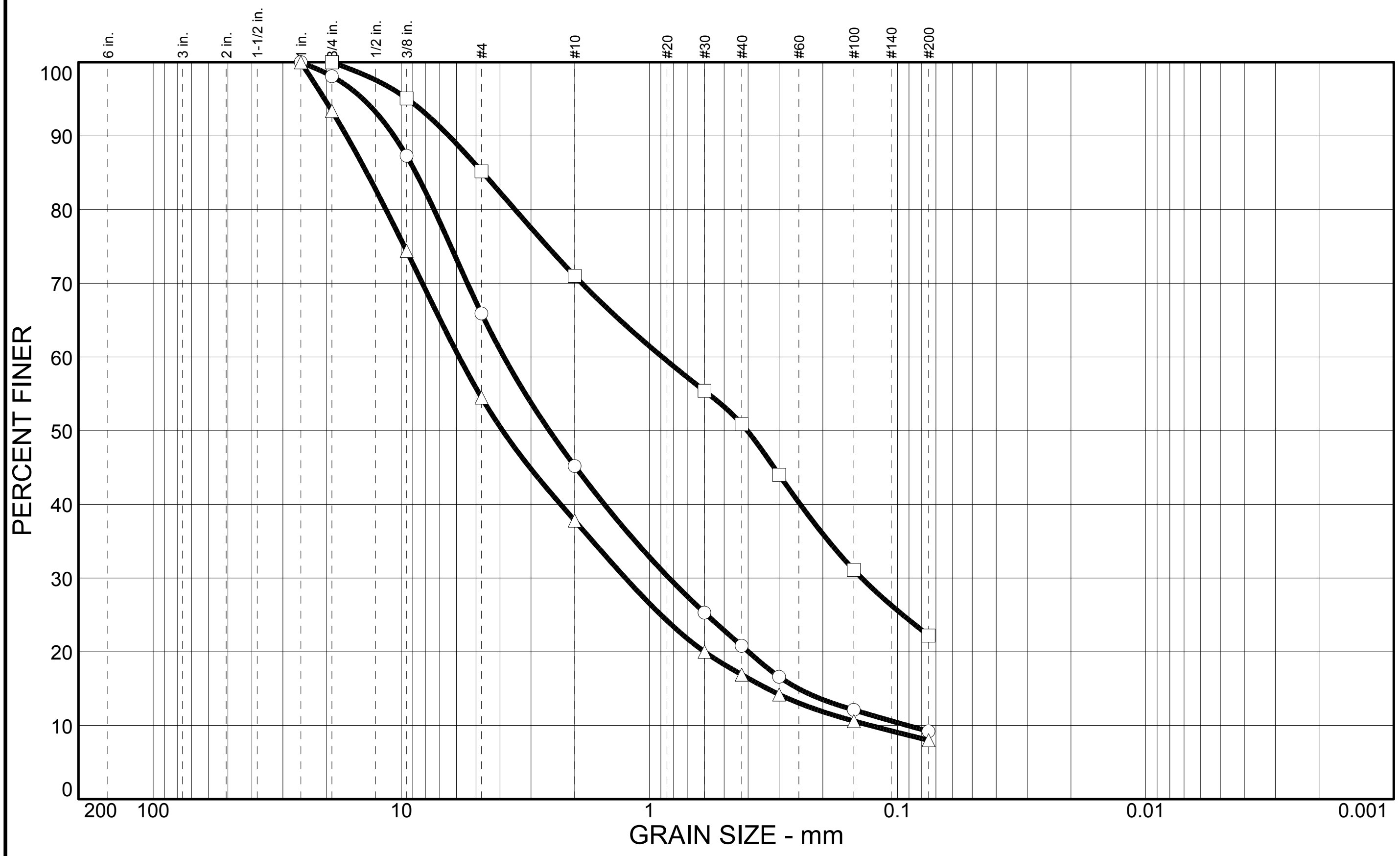
#200 Sieve Wash Analysis
ASTM D 1140

Job No.:	250-051	**Project No.:**	115400	**Run By:**	MD
Client:	GEI Consultants	**Date:**	4/18/2012	**Checked By:**	DC
Project:	Lower Llagas Creek				

Boring:	B-59+00W	B-65+00E	B-78+00W	B-132+50E	B-92+50W	B-107+00W		
Sample:								
Depth, ft.:	4-9	4-9	5-10	2-7	4-10	3-8		
Soil Type:	Dark Gray Fat CLAY	Dark Olive Brown Fat CLAY w/ Sand	Dark Gray Fat CLAY	Dark Olive Brown Sandy Lean CLAY	Dark Gray Fat CLAY w/ Sand	Dark Gray Fat CLAY w/ Sand		
Wt of Dish & Dry Soil, gm	717.5	839.0	698.6	667.3	530.0	615.1		
Weight of Dish, gm	318.2	318.2	278.2	305.7	155.9	304.4		
Weight of Dry Soil, gm	399.3	520.8	420.4	361.6	374.1	310.7		
Wt. Ret. on #4 Sieve, gm	8.8	29.3	0.8	10.1	6.0	3.6		
Wt. Ret. on #200 Sieve, gm	50.9	156.1	59.0	122.6	56.3	56.1		
% Gravel	**2.2**	**5.6**	**0.2**	**2.8**	**1.6**	**1.2**		
% Sand	**10.5**	**24.3**	**13.8**	**31.1**	**13.4**	**16.9**		
% Silt & Clay	**87.2**	**70.0**	**86.0**	**66.1**	**85.0**	**81.9**		

Remarks: As an added benefit to our clients, the gravel fraction may be included in this report. Whether or not it is included is dependent upon both the technician's time available and if there is a significant enough amount of gravel. The gravel is always included in the percent retained on the #200 sieve but may not be weighed separately to determine the percentage, especially if there is only a trace amount, (5% or less).

Particle Size Distribution Report



	% COBBLES	% GRAVEL	% SAND	% SILT	% CLAY	USCS	AASHTO	PL	LL
○		34.1	56.7	9.2		SW-SM			
□		14.8	63.0	22.2					
△		45.5	46.5	8.0					

SIEVE inches size	PERCENT FINER ○	□	△
1"	100.0		100.0
3/4"	98.1	100.0	93.4
3/8"	87.3	95.1	74.4
	GRAIN SIZE		
D_{60}	3.86	0.887	5.85
D_{30}	0.833	0.139	1.25
D_{10}	0.0913		0.129
	COEFFICIENTS		
C_c	1.97		2.07
C_u	42.26		45.33

SIEVE number size	PERCENT FINER ○	□	△
#4	65.9	85.2	54.5
#10	45.2	71.0	37.8
#30	25.3	55.4	20.0
#40	20.8	50.9	16.9
#50	16.6	44.0	14.2
#100	12.1	31.1	10.6
#200	9.2	22.2	8.0

SOIL DESCRIPTION

○ Olive Brown Well-Graded SAND w/ Clay & Gravel

□ Dark Greenish Gray Clayey SAND

△ Olive Brown Well-Graded SAND w/ Clay & Gravel

REMARKS:

○

□

△

○ Source: B-107+00W	Sample No.: 12	Elev./Depth: 24'
□ Source: B-92+50E		Elev./Depth: 8'
△ Source: B-92+50W	Sample No.: 14	Elev./Depth: 30'

COOPER TESTING LABORATORY

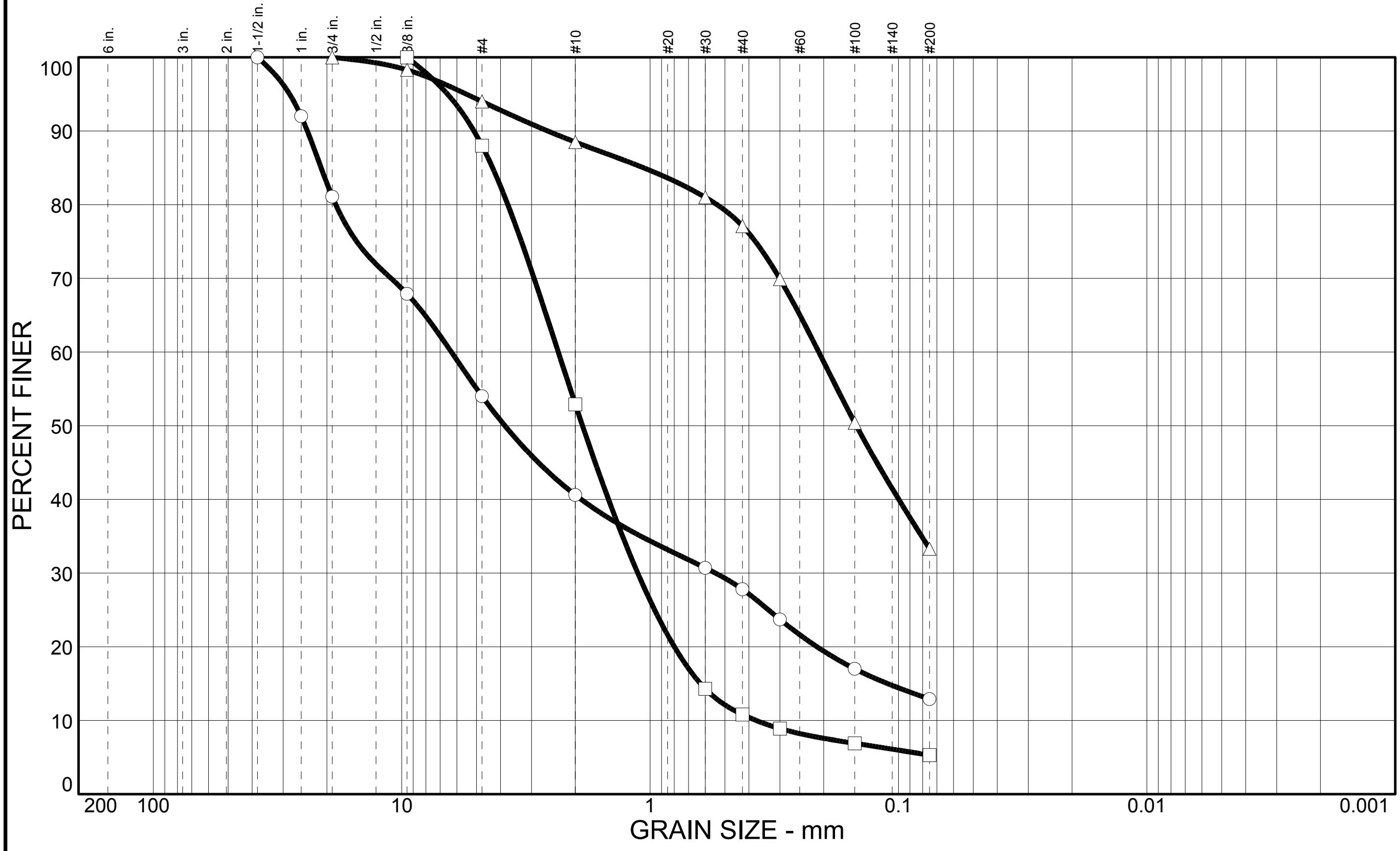
Client: GEI Consultants

Project: Lower Llagas Creek - 115400

Project No.: 250-049

Figure

Particle Size Distribution Report



	% COBBLES	% GRAVEL	% SAND	% SILT	% CLAY	USCS	AASHTO	PL	LL
○		46.0	41.1	12.9					
□		12.0	82.7	5.3					
△		6.0	60.7	33.3					

SIEVE inches size	PERCENT FINER		
	○	□	△
1.5"	100.0		
1"	92.0		
3/4"	81.1		100.0
3/8"	67.9	100.0	98.3
	GRAIN SIZE		
D_{60}	6.31	2.34	0.209
D_{30}	0.546	1.12	
D_{10}		0.375	
	COEFFICIENTS		
C_c		1.43	
C_u		6.26	

SIEVE number size	PERCENT FINER		
	○	□	△
#4	54.0	88.0	94.0
#10	40.6	52.9	88.5
#30	30.7	14.3	81.0
#40	27.8	10.8	77.1
#50	23.7	8.9	69.9
#100	17.0	6.9	50.4
#200	12.9	5.3	33.3

SOIL DESCRIPTION

○ Olive Brown Clayey GRAVEL w/ Sand

□ Olive Brown Well-Graded SAND w/ Clay

△ Mottled Greenish Gray Clayey SAND

REMARKS:

○

□

△

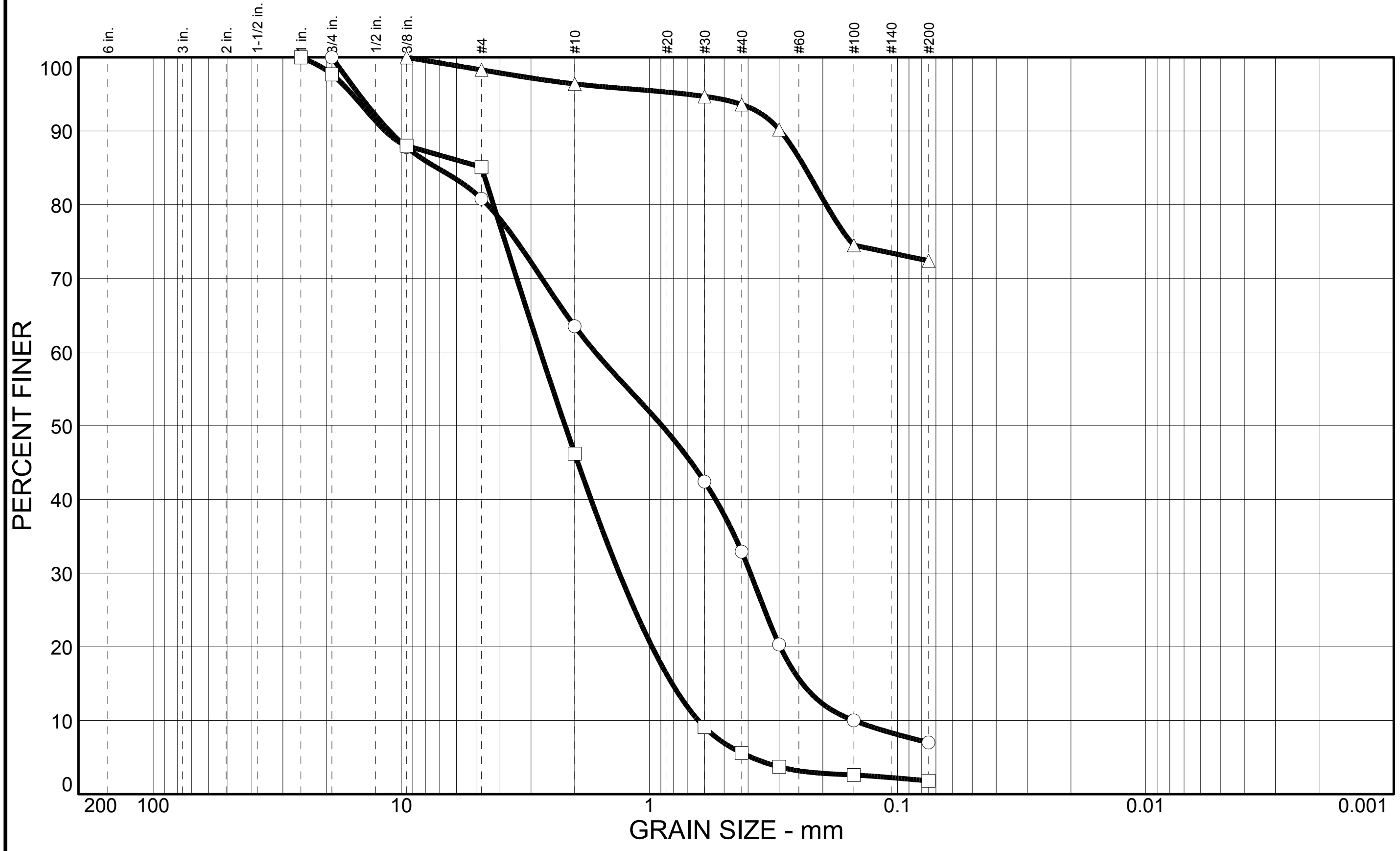
○ Source: B-127+00W Sample No.: 10 Elev./Depth: 25'
□ Source: B-127+00W Sample No.: 11 Elev./Depth: 29-30.5'
△ Source: B-107+00W Sample No.: 10 Elev./Depth: 20'

COOPER TESTING LABORATORY

Client: GEI Consultants
Project: Lower Llagas Creek - 115400

Project No.: 250-049 Figure

Particle Size Distribution Report



	% COBBLES	% GRAVEL	% SAND	% SILT	% CLAY	USCS	AASHTO	PL	LL
○		19.2	73.8	7.0					
□		14.9	83.3	1.8					
△		1.7	25.9	72.4					

SIEVE inches size	PERCENT FINER ○	□	△
1"		100.0	
3/4"	100.0	97.7	
3/8"	87.8	88.0	100.0
	GRAIN SIZE		
D_{60}	1.65	2.75	
D_{30}	0.392	1.32	
D_{10}	0.150	0.635	
	COEFFICIENTS		
C_c	0.62	1.00	
C_u	11.03	4.32	

SIEVE number size	PERCENT FINER ○	□	△
#4	80.8	85.1	98.3
#10	63.5	46.2	96.4
#30	42.4	9.1	94.7
#40	32.9	5.6	93.6
#50	20.3	3.7	90.2
#100	10.0	2.6	74.5
#200	7.0	1.8	72.4

SOIL DESCRIPTION

○ Olive Brown Poorly Graded SAND w/ Clay & Gravel

□ Olive Brown Poorly Graded SAND

△ Brown CLAY w/ Sand

REMARKS:

○

□ This sample size was small relative to the largest particle size. This could cause an irregular shape of the gradation curve.

△

○ Source: B-132+00W		Elev./Depth: 25'
□ Source: B-132+00W	Sample No.: 16	Elev./Depth: 34'
△ Source: B-127+00W	Sample No.: 8	Elev./Depth: 17'

COOPER TESTING LABORATORY

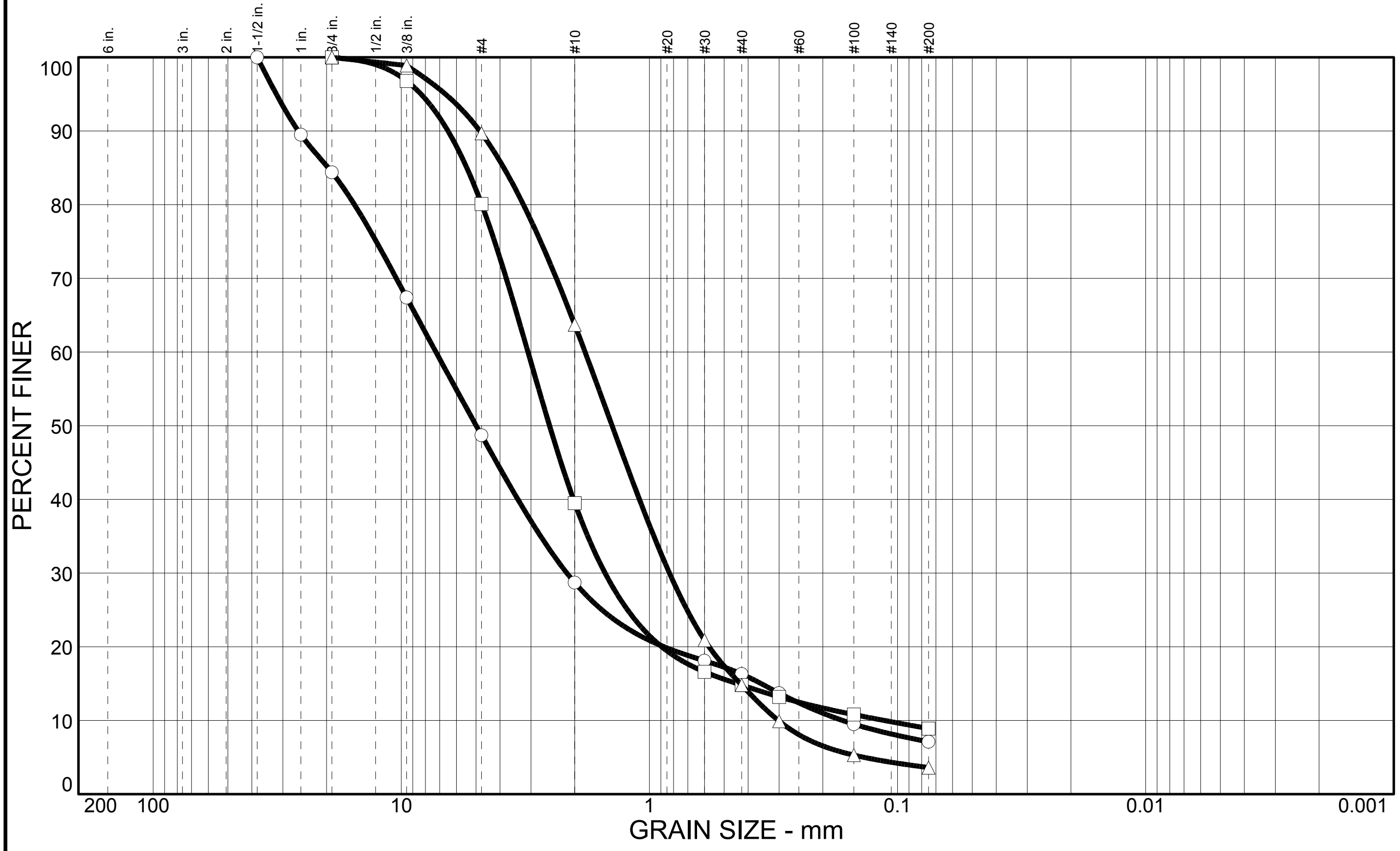
Client: GEI Consultants

Project: Lower Llagas Creek - 115400

Project No.: 250-049

Figure

Particle Size Distribution Report



	% COBBLES	% GRAVEL	% SAND	% SILT	% CLAY	USCS	AASHTO	PL	LL
○		51.3	41.6	7.1					
□		19.9	71.2	8.9		SP-SM			
△		10.3	86.1	3.6					

SIEVE inches size	PERCENT FINER ○	□	△
1.5"	100.0		
1"	89.5		
3/4"	84.4	100.0	100.0
3/8"	67.4	96.8	98.9
	GRAIN SIZE		
D_{60}	7.25	3.09	1.82
D_{30}	2.15	1.51	0.831
D_{10}	0.167	0.113	0.303
	COEFFICIENTS		
C_c	3.83	6.53	1.25
C_u	43.52	27.31	6.01

SIEVE number size	PERCENT FINER ○	□	△
#4	48.7	80.1	89.7
#10	28.7	39.5	63.7
#30	18.1	16.6	20.9
#40	16.3	14.8	14.8
#50	13.7	13.2	9.9
#100	9.5	10.8	5.3
#200	7.1	8.9	3.6

SOIL DESCRIPTION

○ Olive Brown Poorly Graded GRAVEL w/ Clay & Sand

□ Olive Brown Poorly Graded SAND w/ Clay & Gravel

△ Olive Brown Well-Graded SAND

REMARKS:

○

□

△

○ Source: B-141+00W	Sample No.: 14	Elev./Depth: 29.5'
□ Source: B-132+50E	Sample No.: 13	Elev./Depth: 29.5'
△ Source: B-132+50E	Sample No.: 16	Elev./Depth: 39'

COOPER TESTING LABORATORY

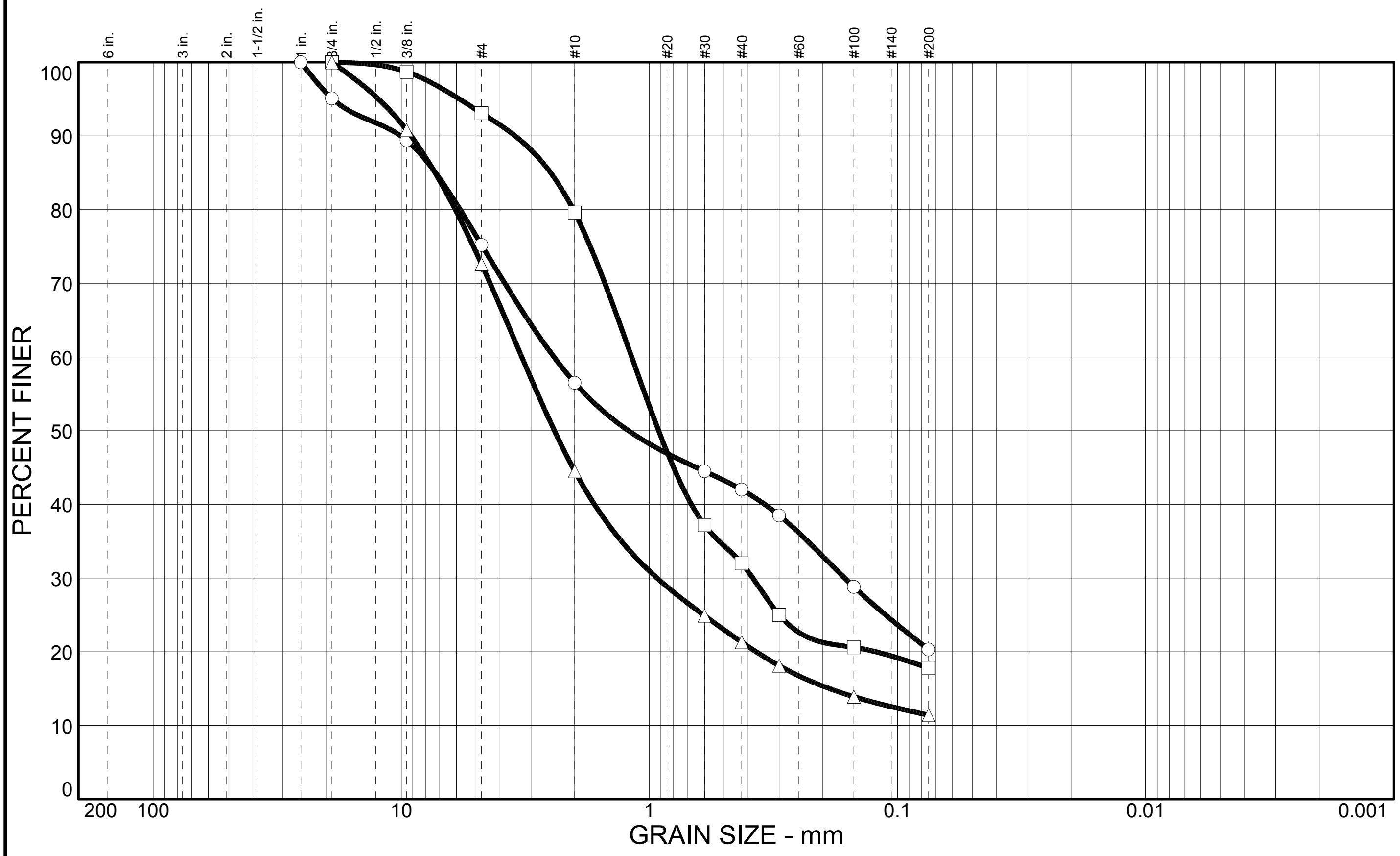
Client: GEI Consultants

Project: Lower Llagas Creek - 115400

Project No.: 250-049

Figure

Particle Size Distribution Report



	% COBBLES	% GRAVEL	% SAND	% SILT	% CLAY	USCS	AASHTO	PL	LL
○		24.8	54.9	20.3					
□		6.9	75.3	17.8					
△		27.4	61.2	11.4					

SIEVE inches size	PERCENT FINER ○	□	△
1"	100.0		
3/4"	95.1	100.0	100.0
3/8"	89.4	98.7	90.8
	GRAIN SIZE		
D_{60}	2.43	1.18	3.27
D_{30}	0.163	0.383	0.932
D_{10}			
	COEFFICIENTS		
C_c			
C_u			

SIEVE number size	PERCENT FINER ○	□	△
#4	75.2	93.1	72.6
#10	56.5	79.6	44.5
#30	44.5	37.2	24.9
#40	42.0	32.0	21.3
#50	38.5	25.0	18.1
#100	28.8	20.6	13.9
#200	20.3	17.8	11.4

SOIL DESCRIPTION

○ Brown Clayey SAND w/ Gravel

□ Olive Brown Silty SAND

△ Olive Brown Poorly Graded SAND w/ Clay & Gravel

REMARKS:

○

□

△

○ Source: B-141+00W	Sample No.: 2	Elev./Depth: 2.5'
□ Source: B-141+00W	Sample No.: 3	Elev./Depth: 5.5'
△ Source: B-141+00W	Sample No.: 13	Elev./Depth: 24'

COOPER TESTING LABORATORY

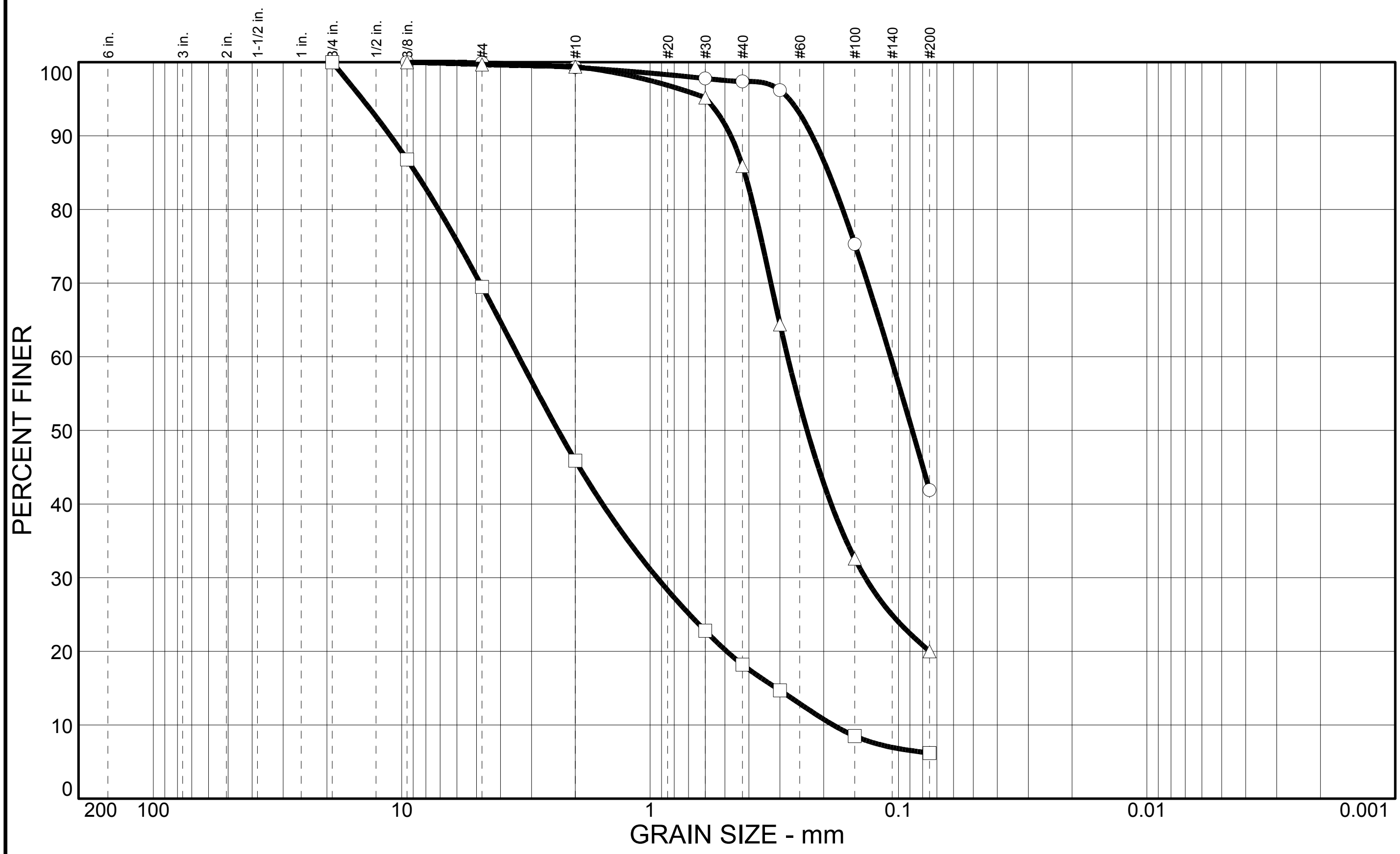
Client: GEI Consultants

Project: Lower Llagas Creek - 115400

Project No.: 250-049

Figure

Particle Size Distribution Report



	% COBBLES	% GRAVEL	% SAND	% SILT	% CLAY	USCS	AASHTO	PL	LL
○		0.1	58.0	41.9					
□		30.5	63.3	6.2					
△		0.3	79.7	20.0					

SIEVE inches size	PERCENT FINER ○	□	△
3/4"		100.0	
3/8"	100.0	86.8	100.0
	GRAIN SIZE		
D_{60}	0.108	3.38	0.280
D_{30}		0.938	0.136
D_{10}		0.183	
	COEFFICIENTS		
C_c		1.42	
C_u		18.44	

SIEVE number size	PERCENT FINER ○	□	△
#4	99.9	69.5	99.7
#10	99.3	45.9	99.4
#30	97.8	22.8	95.2
#40	97.4	18.2	85.9
#50	96.2	14.7	64.4
#100	75.3	8.5	32.6
#200	41.9	6.2	20.0

SOIL DESCRIPTION

○ Olive Brown Silty SAND

□ Olive Brown Well-Graded SAND w/ Silt & Gravel

△ Dark Brown Silty SAND

REMARKS:

○

□

△

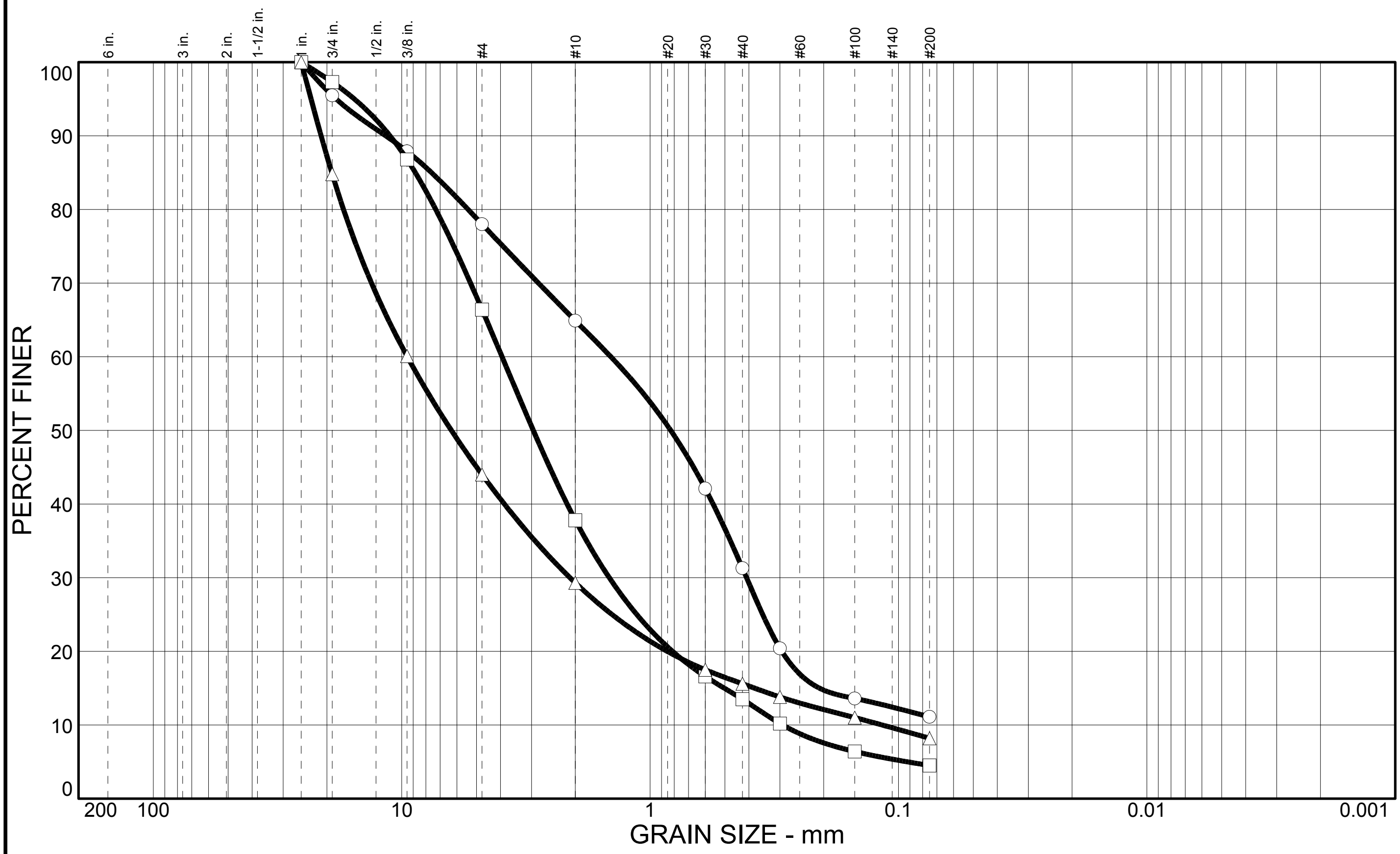
○ Source: B-166+50E Elev./Depth: 6.5'
□ Source: B-166+50E Elev./Depth: 35'
△ Source: B-173+50W Sample No.: 4 Elev./Depth: 6'

COOPER TESTING LABORATORY

Client: GEI Consultants
Project: Lower Llagas Creek - 115400

Project No.: 250-049 Figure

Particle Size Distribution Report



	% COBBLES	% GRAVEL	% SAND	% SILT	% CLAY	USCS	AASHTO	PL	LL
○		22.0	66.9	11.1					
□		33.6	61.9	4.5					
△		56.0	35.8	8.2					

SIEVE inches size	PERCENT FINER ○	PERCENT FINER □	PERCENT FINER △
1"	100.0	100.0	100.0
3/4"	95.5	97.3	84.8
3/8"	87.9	86.8	60.1
	GRAIN SIZE		
D_{60}	1.44	3.95	9.49
D_{30}	0.409	1.46	2.10
D_{10}		0.293	0.116
	COEFFICIENTS		
C_c		1.84	4.00
C_u		13.47	81.60

SIEVE number size	PERCENT FINER ○	PERCENT FINER □	PERCENT FINER △
#4	78.0	66.4	44.0
#10	64.9	37.8	29.3
#30	42.1	16.6	17.5
#40	31.3	13.5	15.6
#50	20.4	10.2	13.8
#100	13.6	6.4	11.0
#200	11.1	4.5	8.2

SOIL DESCRIPTION

○ Brown Poorly Graded SAND w/ Clay & Gravel

□ Olive Brown Well-Graded SAND w/ Gravel

△ Yellowish Brown Poorly Graded GRAVEL w/ Clay & Sand

REMARKS:

○

□

△

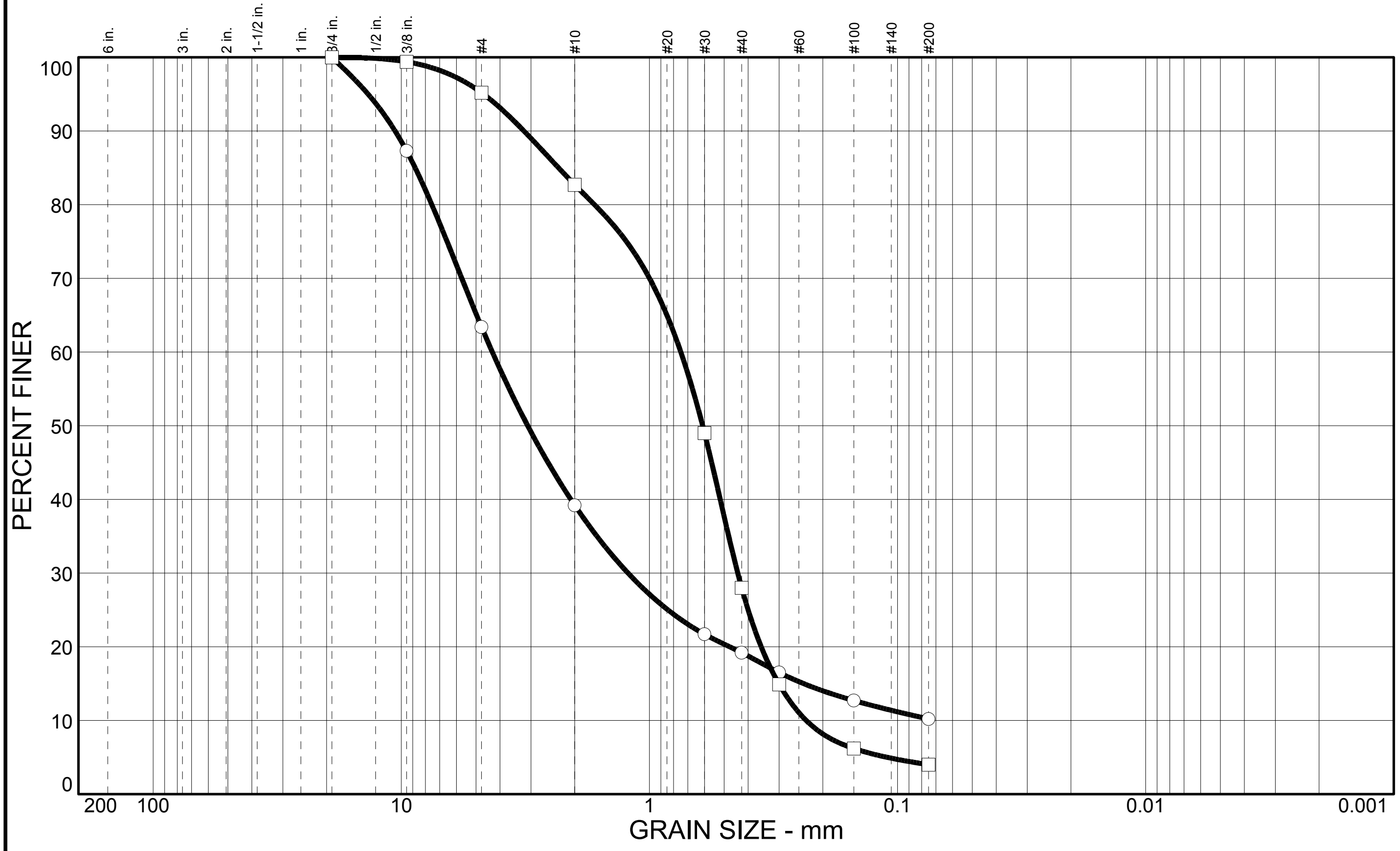
○ Source: B-173+50W	Sample No.: 14	Elev./Depth: 25'
□ Source: B-173+50W		Elev./Depth: 34'
△ Source: B-148+00E	Sample No.: 12	Elev./Depth: 30'

COOPER TESTING LABORATORY

Client: GEI Consultants
Project: Lower Llagas Creek - 115400

Project No.: 250-049
Figure

Particle Size Distribution Report



	% COBBLES	% GRAVEL	% SAND	% SILT	% CLAY	USCS	AASHTO	PL	LL
○		36.6	53.2	10.2					
□		4.8	91.2	4.0					

SIEVE inches size	PERCENT FINER ○	□	
3/4"	100.0	100.0	
3/8"	87.3	99.4	
	GRAIN SIZE		
D_{60}	4.30	0.748	
D_{30}	1.22	0.441	
D_{10}		0.233	
	COEFFICIENTS		
C_c		1.11	
C_u		3.20	

SIEVE number size	PERCENT FINER ○	□	
#4	63.4	95.2	
#10	39.2	82.7	
#30	21.7	49.0	
#40	19.2	28.0	
#50	16.5	14.9	
#100	12.7	6.2	
#200	10.2	4.0	

SOIL DESCRIPTION

○ Olive Brown Poorly Graded SAND w/ Clay & Gravel

□ Dark Brown Poorly Graded SAND

REMARKS:

○

□

○ Source: B-59+00W	Sample No.: 17	Elev./Depth: 44'
□ Source: B-50+00W	Sample No.: 22	Elev./Depth: 49'

COOPER TESTING LABORATORY

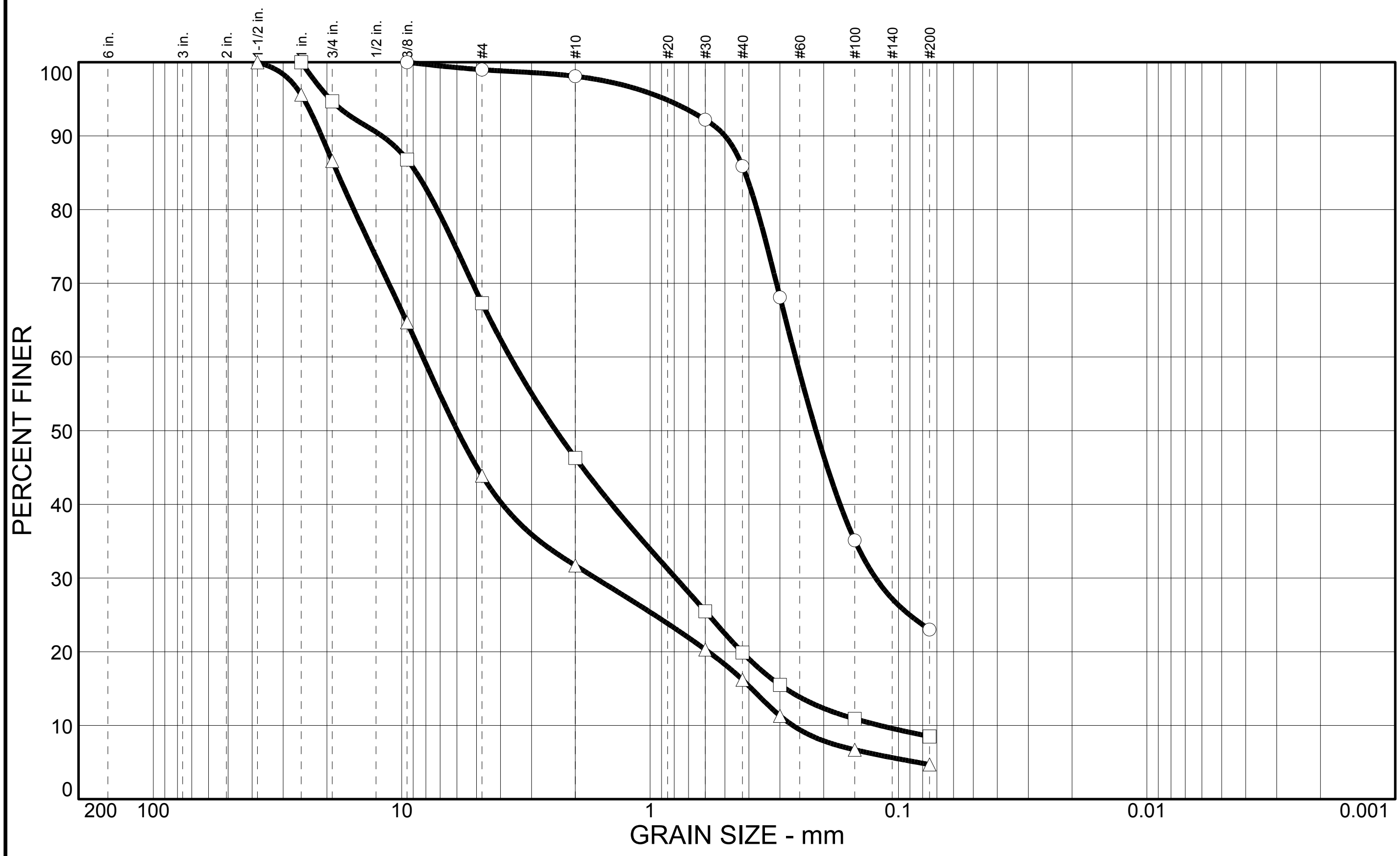
Client: GEI Consultants

Project: Lower Llagas Creek - 115400

Project No.: 250-049

Figure

Particle Size Distribution Report



	% COBBLES	% GRAVEL	% SAND	% SILT	% CLAY	USCS	AASHTO	PL	LL
○		1.0	76.0	23.0					
□		32.7	58.8	8.5					
△		56.1	39.2	4.7		GW			

SIEVE	PERCENT FINER		
inches size	○	□	△
1.5"			100.0
1"		100.0	95.6
3/4"		94.7	86.6
3/8"	100.0	86.8	64.7
	GRAIN SIZE		
D_{60}	0.260	3.66	8.23
D_{30}	0.124	0.788	1.66
D_{10}		0.119	0.266
	COEFFICIENTS		
C_c		1.43	1.26
C_u		30.75	30.89

SIEVE	PERCENT FINER		
number size	○	□	△
#4	99.0	67.3	43.9
#10	98.1	46.3	31.7
#30	92.2	25.5	20.3
#40	85.9	19.9	16.2
#50	68.1	15.5	11.3
#100	35.1	10.9	6.7
#200	23.0	8.5	4.7

SOIL DESCRIPTION

○ Bluish Gray Clayey SAND

□ Olive Brown Well-Graded SAND w/ Clay & Gravel

△ Bluish Black Well-Graded GRAVEL w/ Sand

REMARKS:

○

□

△

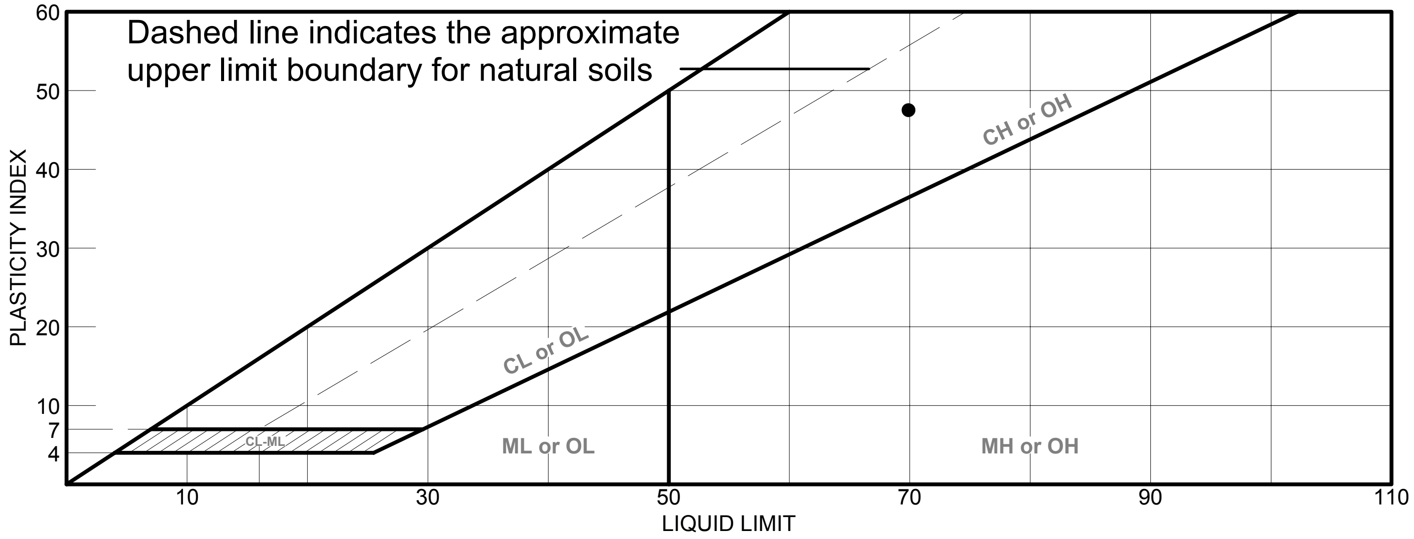
○ Source: B-78+00W Sample No.: 17 Elev./Depth: 29'
□ Source: B-78+00W Sample No.: 19 Elev./Depth: 39'
△ Source: B-65+00E Sample No.: 20 Elev./Depth: 45.5'

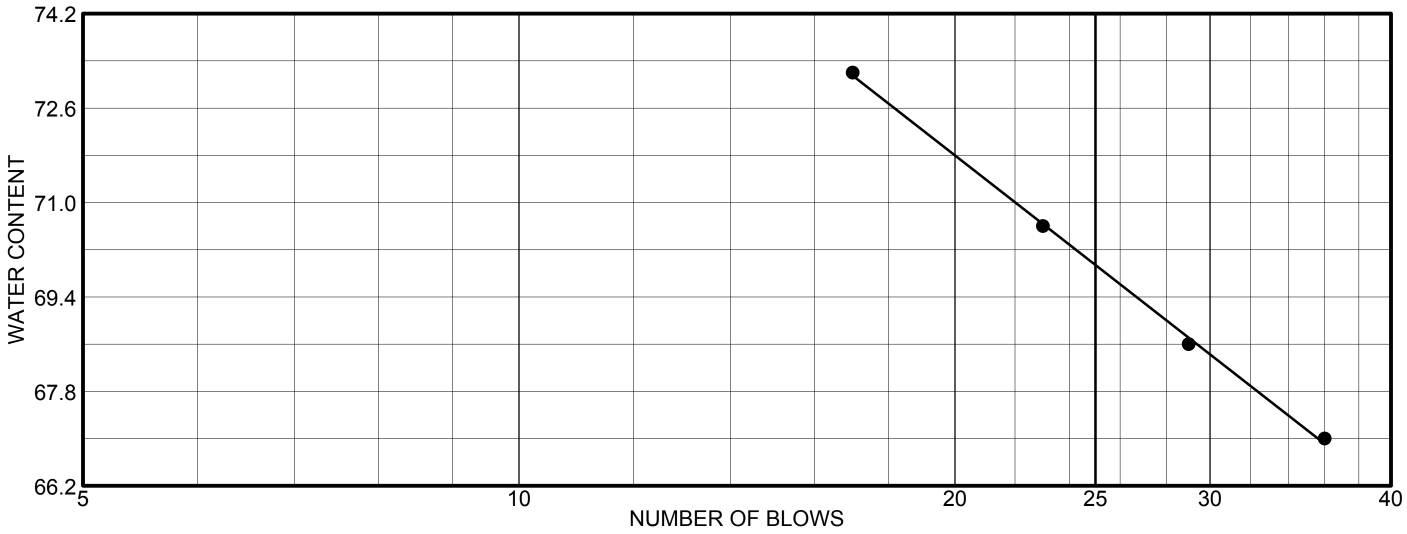
COOPER TESTING LABORATORY

Client: GEI Consultants
Project: Lower Llagas Creek - 115400

Project No.: 250-049 Figure

LIQUID AND PLASTIC LIMITS TEST REPORT





	MATERIAL DESCRIPTION	LL	PL	PI	%<#40	%<#200	USCS
●	Very Dark Gray Fat CLAY	69.9	22.4	47.5			

Project No. 250-050 **Client:** GEI Consultants

Project: Lower Llagas Creek -115400

● **Source:** B-50+00W **Elev./Depth:** 4-9'

Remarks:

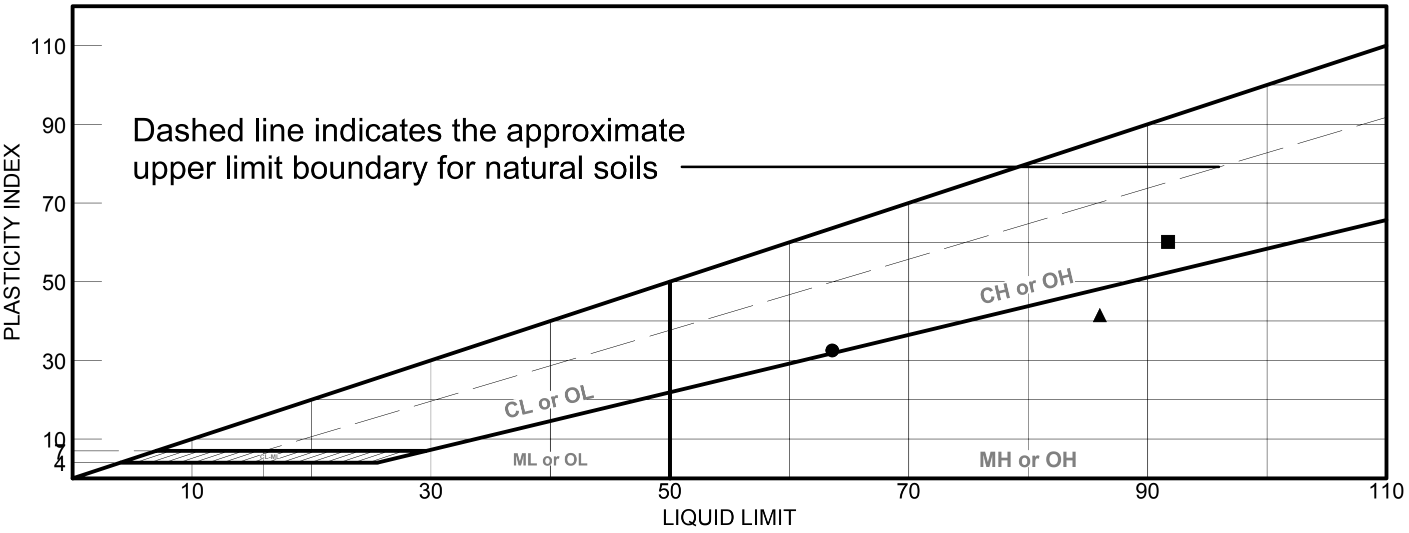
●

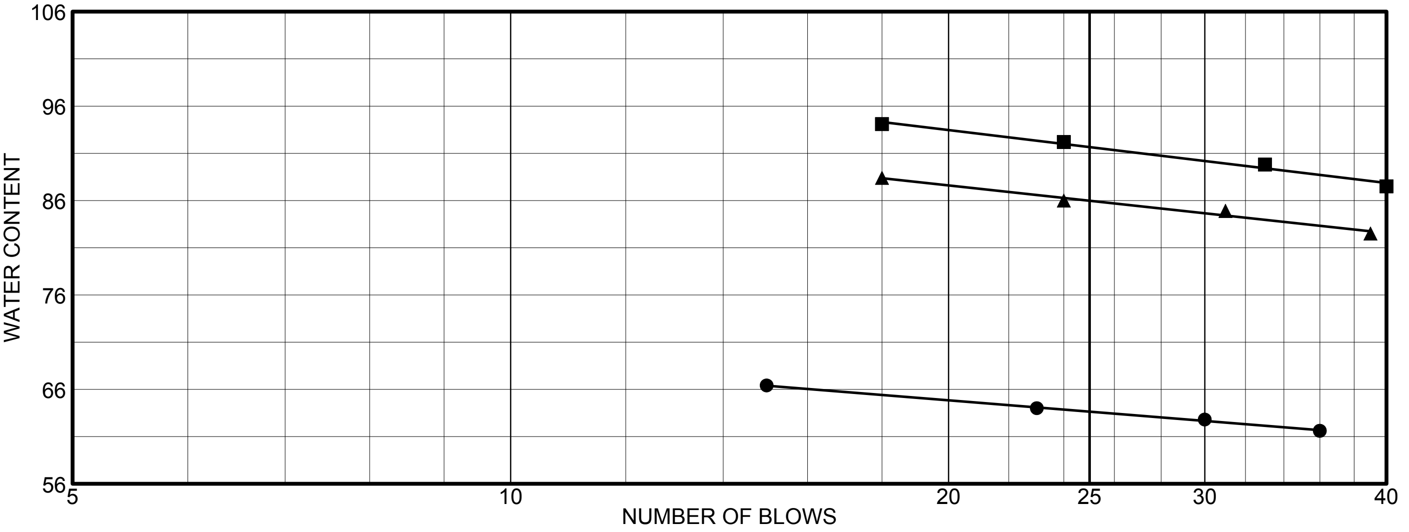
LIQUID AND PLASTIC LIMITS TEST REPORT

COOPER TESTING LABORATORY

Figure

LIQUID AND PLASTIC LIMITS TEST REPORT





	MATERIAL DESCRIPTION	LL	PL	PI	%<#40	%<#200	USCS
●	Dark Gray Fat CLAY w/ organics	63.6	31.1	32.5			
■	Dark Gray Fat CLAY w/ organics	91.7	31.6	60.1			
▲	Very Dark Bluish Gray Elastic SILT w/ organics	86.0	44.5	41.5			

Project No. 250-049 **Client:** GEI Consultants

Project: Lower Llagas Creek - 115400

● **Source:** B-50+00W **Sample No.:** 9 **Elev./Depth:** 16-18'
■ **Source:** B-50+00W **Sample No.:** 11 **Elev./Depth:** 20-22'
▲ **Source:** B-50+00W **Sample No.:** 14 **Elev./Depth:** 25'

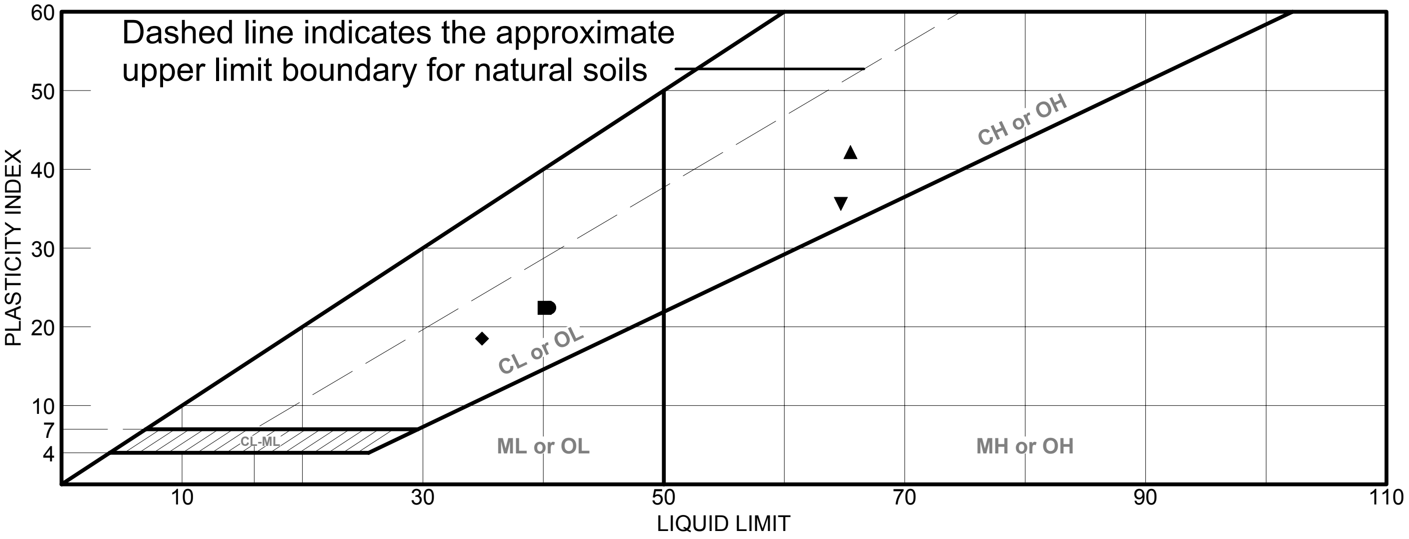
Remarks:
●
■
▲

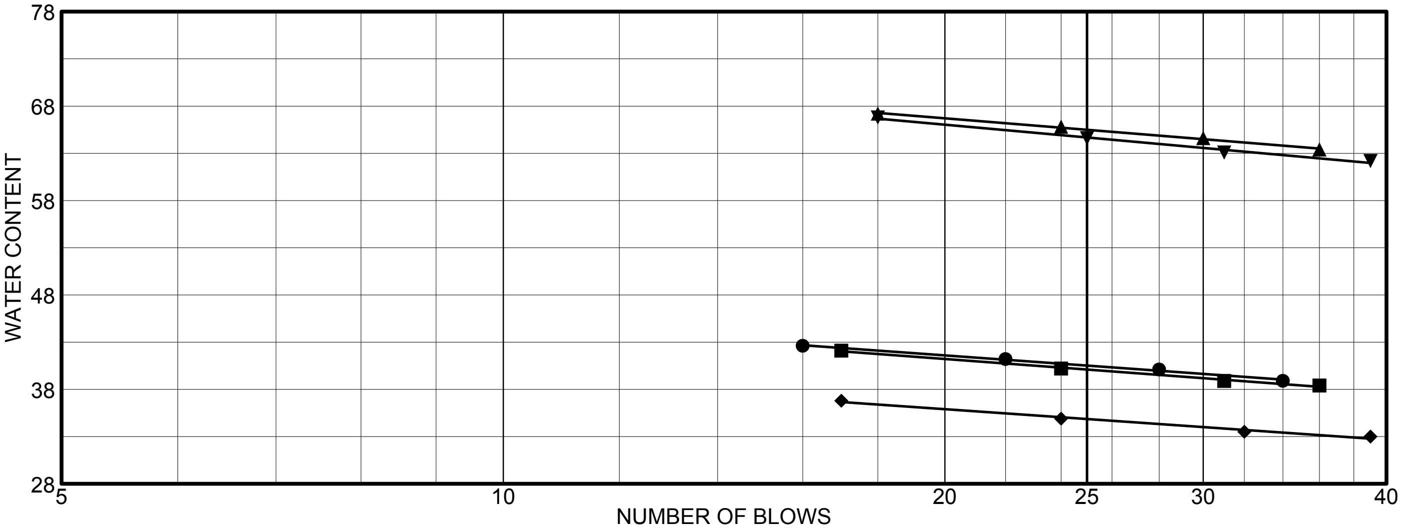
LIQUID AND PLASTIC LIMITS TEST REPORT

COOPER TESTING LABORATORY

Figure

LIQUID AND PLASTIC LIMITS TEST REPORT





	MATERIAL DESCRIPTION	LL	PL	PI	%<#40	%<#200	USCS
●	Olive Brown Lean Clayey SAND, trace Gravel	40.5	18.1	22.4			
■	Dark Olive Brown Lean CLAY w/ Sand near Sandy Lean CLAY	40.1	17.7	22.4			
▲	Very Dark Greenish Gray Fat CLAY	65.5	23.3	42.2			
◆	Olive Sandy Lean CLAY	34.9	16.4	18.5			
▼	Dark Gray Sandy Fat CLAY w/ Gravel	64.7	29.1	35.6			

Project No. 250-049 **Client:** GEI Consultants

Project: Lower Llagas Creek - 115400

● **Source:** B-127+00W **Sample No.:** 3 **Elev./Depth:** 6'
■ **Source:** B-127+00W **Sample No.:** 6 **Elev./Depth:** 14-16'
▲ **Source:** B-116+50E **Sample No.:** 5 **Elev./Depth:** 10-12'
◆ **Source:** B-116+50E **Sample No.:** 11 **Elev./Depth:** 20'
▼ **Source:** B-107+00W **Sample No.:** 3 **Elev./Depth:** 6'

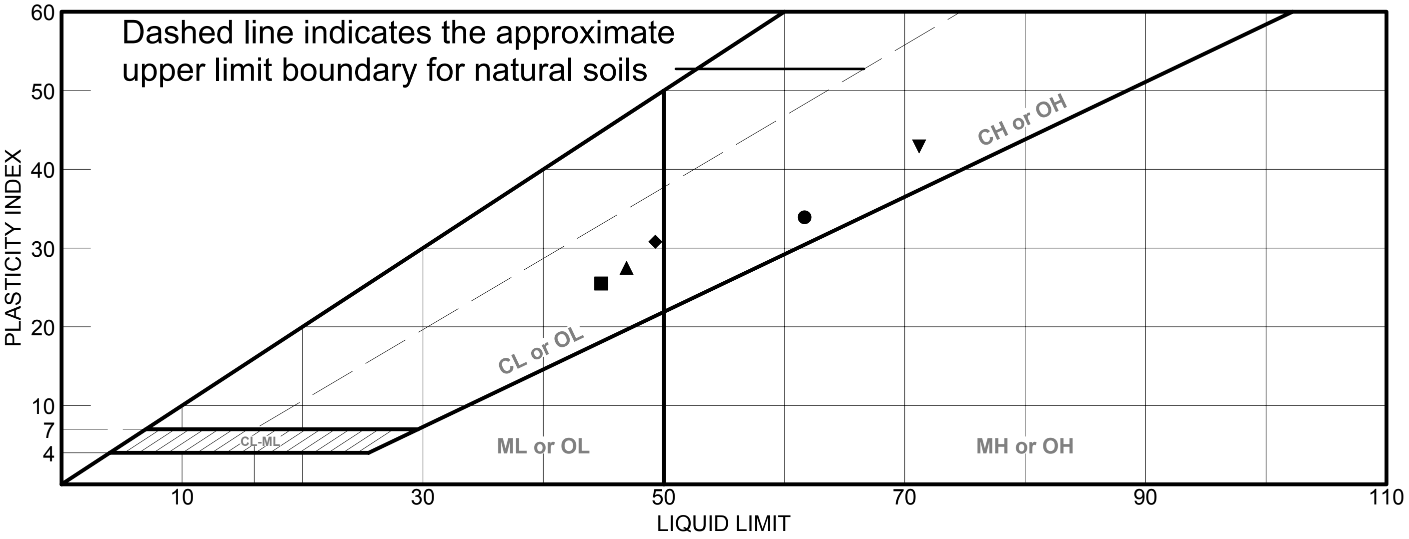
Remarks:
●
■
▲
◆
▼

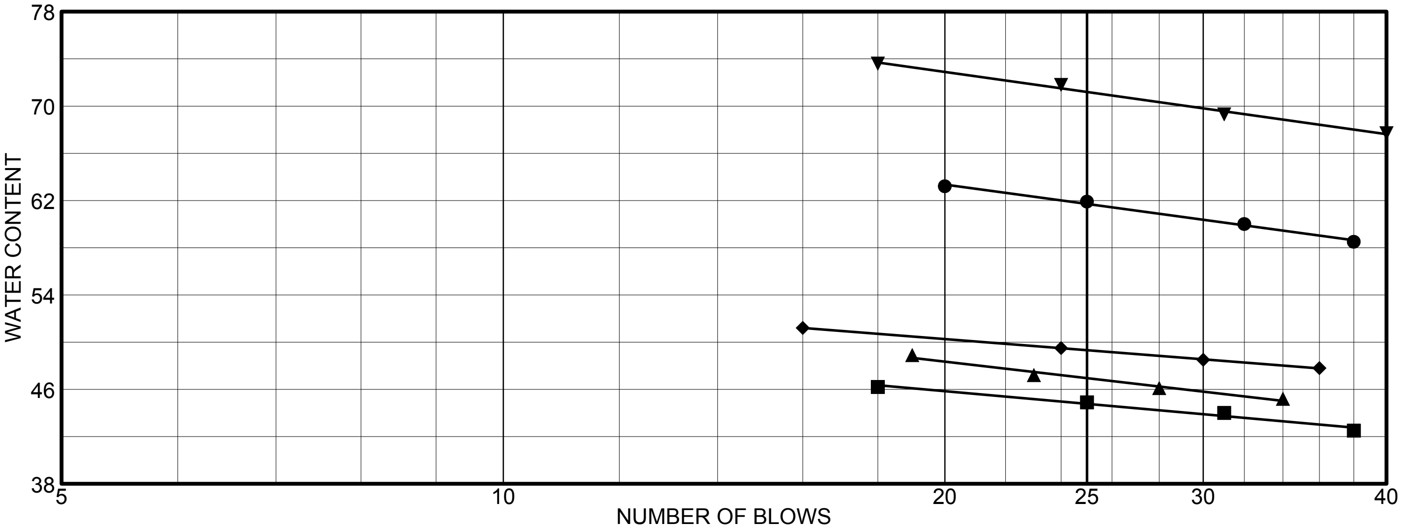
LIQUID AND PLASTIC LIMITS TEST REPORT

COOPER TESTING LABORATORY

Figure

LIQUID AND PLASTIC LIMITS TEST REPORT





	MATERIAL DESCRIPTION	LL	PL	PI	%<#40	%<#200	USCS
●	Dark Olive Brown Fat CLAY	61.7	27.8	33.9			
■	Dark Olive Brown Lean CLAY w/ Sand	44.8	19.3	25.5			
▲	Olive Brown Lean CLAY w/ Sand	46.9	19.4	27.5			
◆	Very Dark Brown Lean CLAY	49.3	18.5	30.8			
▼	Dark Olive Brown Fat CLAY	71.2	28.3	42.9			

Project No. 250-049 **Client:** GEI Consultants

Project: Lower Llagas Creek - 115400

● **Source:** B-148+00E **Sample No.:** 3 **Elev./Depth:** 6'
■ **Source:** B-148+00E **Sample No.:** 8 **Elev./Depth:** 18-20'
▲ **Source:** B-141+00W **Sample No.:** 6 **Elev./Depth:** 10.5'
◆ **Source:** B-132+50E **Elev./Depth:** 10-12'
▼ **Source:** B-132+00W **Sample No.:** 3 **Elev./Depth:** 6'

Remarks:
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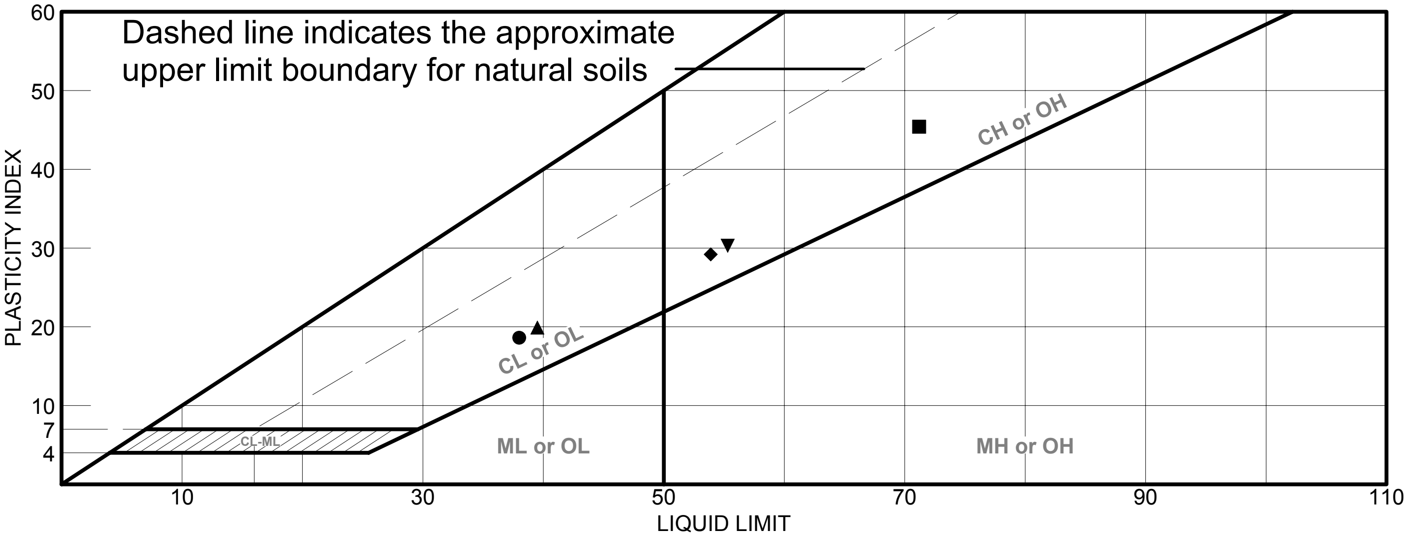
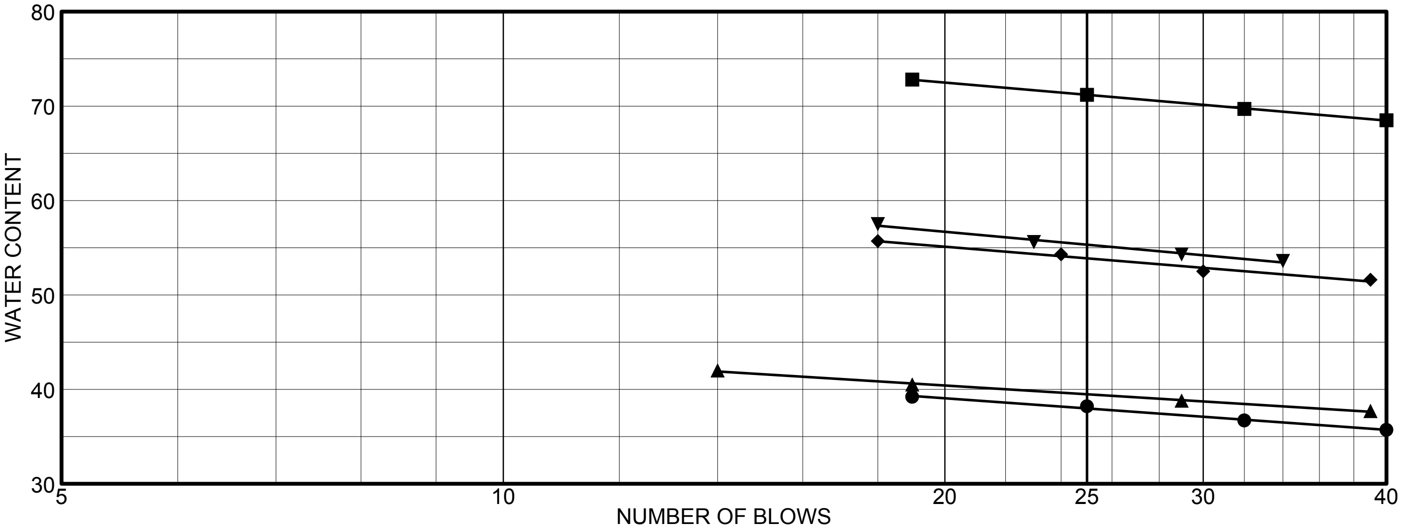
LIQUID AND PLASTIC LIMITS TEST REPORT

COOPER TESTING LABORATORY

Figure

LIQUID AND PLASTIC LIMITS TEST REPORT


Dashed line indicates the approximate upper limit boundary for natural soils



	MATERIAL DESCRIPTION	LL	PL	PI	%<#40	%<#200	USCS
●	Very Dark Bluish Gray Lean CLAY w/ Sand	38.0	19.4	18.6			
■	Dark Olive Brown Fat CLAY w/ Sand	71.2	25.8	45.4			
▲	Dark Gray Lean Clayey SAND w/ Gravel	39.5	19.6	19.9			
◆	Bluish Black Sandy Fat CLAY	53.9	24.7	29.2			
▼	Very Dark Bluish Gray Fat CLAY w/ Sand	55.3	25.0	30.3			

Project No. 250-049 **Client:** GEI Consultants

Project: Lower Llagas Creek - 115400

● **Source:** B-65+00E **Sample No.:** 11 **Elev./Depth:** 16-18'
■ **Source:** B-59+00W **Sample No.:** 3 **Elev./Depth:** 6'
▲ **Source:** B-59+00W **Elev./Depth:** 14-16'
◆ **Source:** B-59+00W **Sample No.:** 12 **Elev./Depth:** 25'
▼ **Source:** B-50+00W **Sample No.:** 7 **Elev./Depth:** 12-14(Tip-1)

Remarks:
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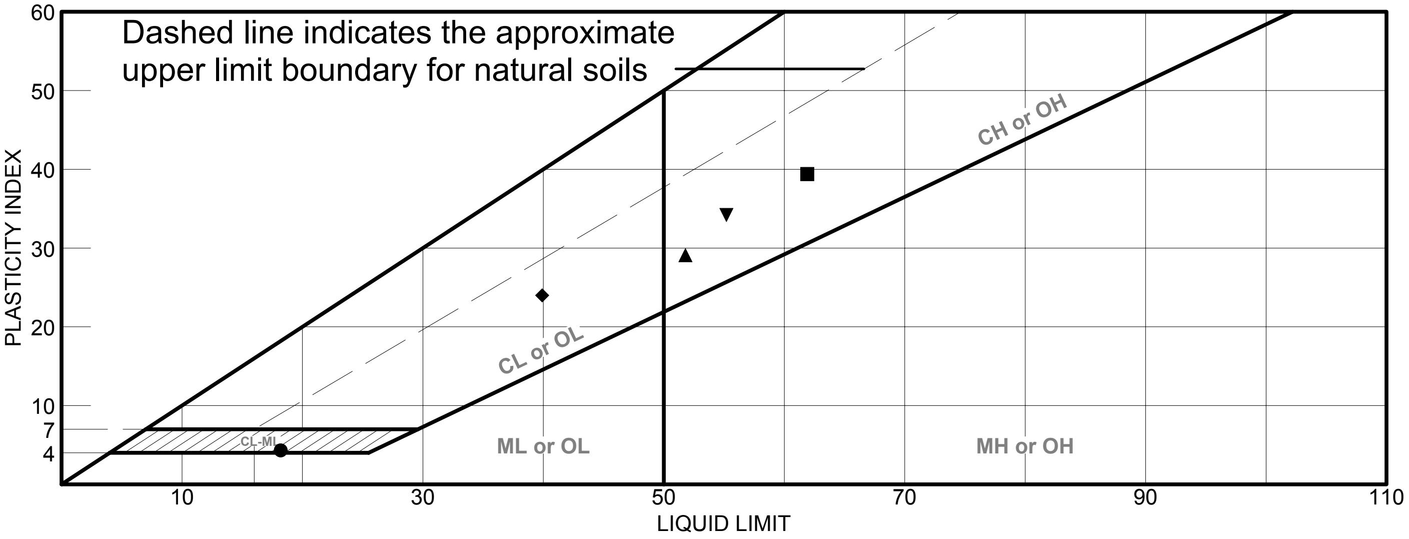
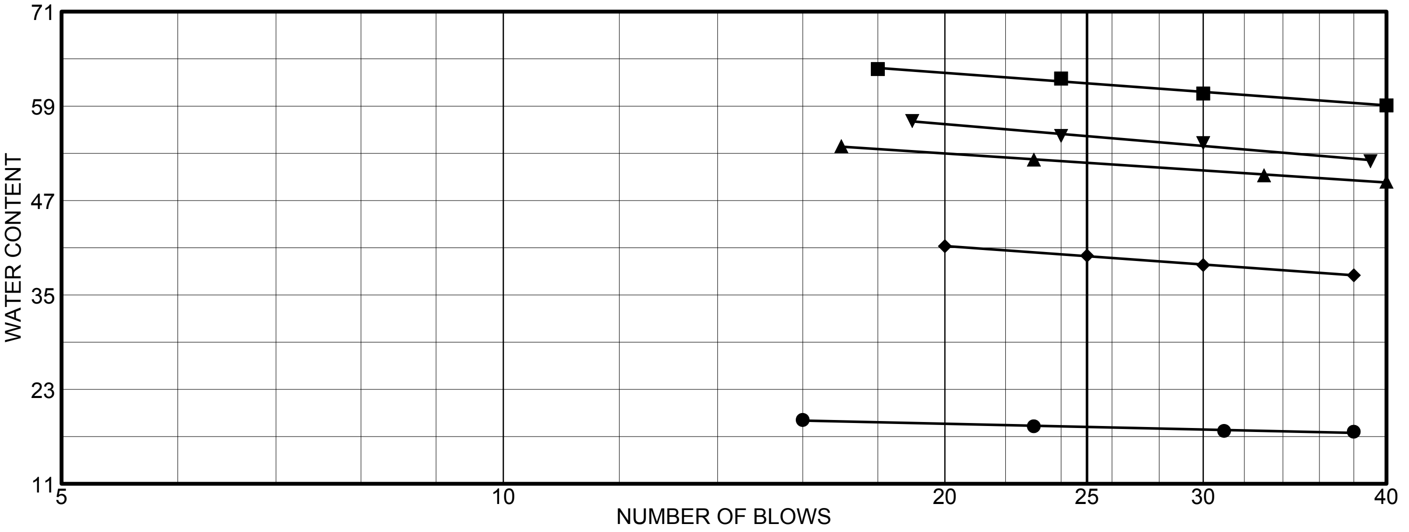
LIQUID AND PLASTIC LIMITS TEST REPORT

COOPER TESTING LABORATORY

Figure

LIQUID AND PLASTIC LIMITS TEST REPORT





	MATERIAL DESCRIPTION	LL	PL	PI	%<#40	%<#200	USCS
●	Dark Olive Brown Silty, Clayey SAND w/ Gravel	18.2	13.9	4.3			
■	Dark Gray Fat CLAY	61.9	22.5	39.4			
▲	Black Fat CLAY w/ Sand, trace Gravel	51.8	22.7	29.1			
◆	Very Dark Gray Lean CLAY	39.9	15.9	24.0			
▼	Black Sandy Fat CLAY	55.2	21.0	34.2			

Project No. 250-049 **Client:** GEI Consultants

Project: Lower Llagas Creek - 115400

● **Source:** B-92+50W **Sample No.:** 16 **Elev./Depth:** 24-26'
■ **Source:** B-78+00W **Sample No.:** 5 **Elev./Depth:** 7'
▲ **Source:** B-78+00W **Sample No.:** 11 **Elev./Depth:** 17'
◆ **Source:** B-78+00W **Sample No.:** 15 **Elev./Depth:** 25-27'
▼ **Source:** B-65+00E **Sample No.:** 6 **Elev./Depth:** 8.5'

Remarks:
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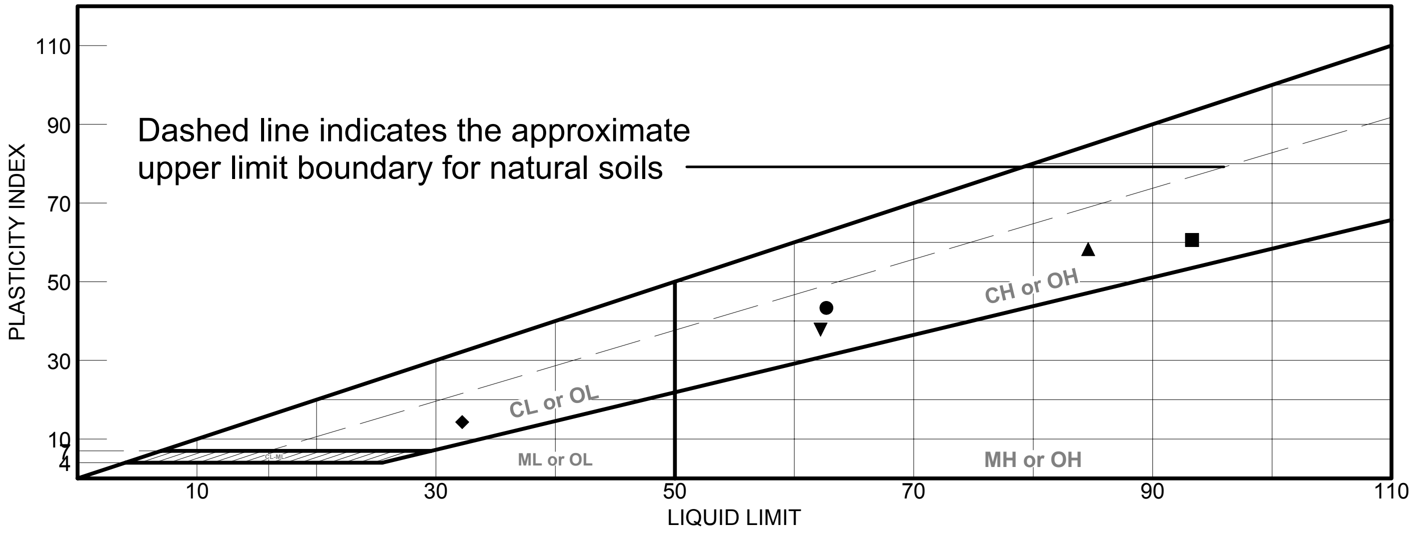
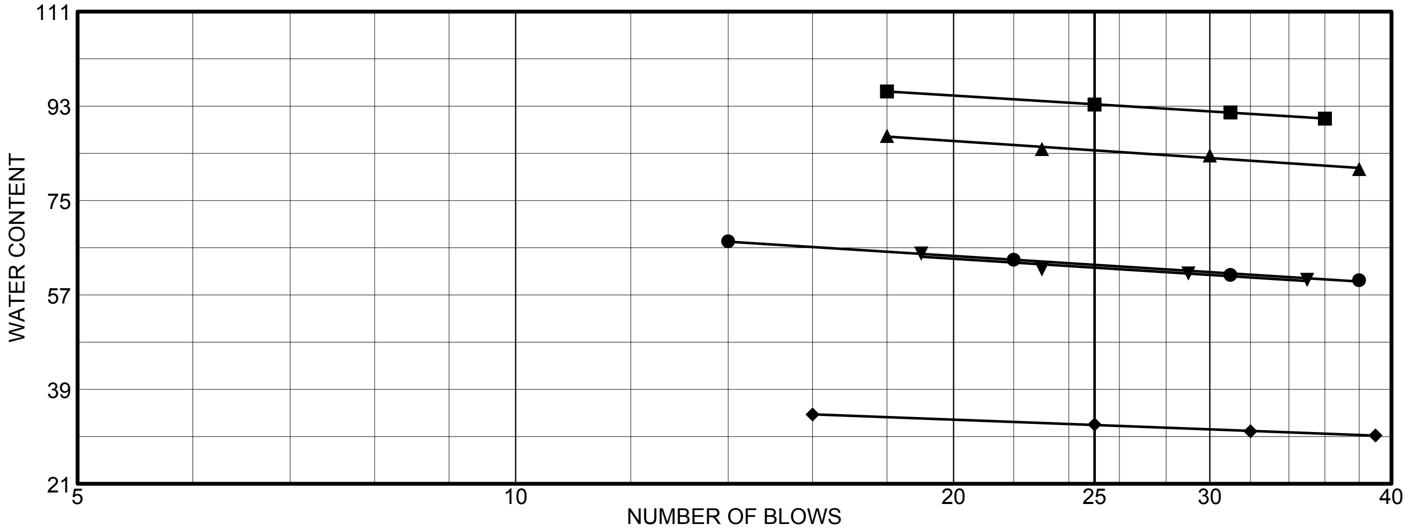
LIQUID AND PLASTIC LIMITS TEST REPORT

COOPER TESTING LABORATORY

Figure

LIQUID AND PLASTIC LIMITS TEST REPORT


Dashed line indicates the approximate upper limit boundary for natural soils



	MATERIAL DESCRIPTION	LL	PL	PI	%<#40	%<#200	USCS
●	Dark Gray Fat CLAY	62.7	19.4	43.3			
■	Very Dark Gray Fat CLAY w/ organics	93.3	32.7	60.6			
▲	Very Dark Gray Fat CLAY	84.6	26.3	58.3			
◆	Olive Lean CLAY w/ Sand	32.2	17.9	14.3			
▼	Dark Gray Fat CLAY w/ Sand, trace Gravel	62.2	24.4	37.8			

Project No. 250-049 **Client:** GEI Consultants

Project: Lower Llagas Creek - 115400

● **Source:** B-107+00W **Sample No.:** 6 **Elev./Depth:** 12-14'
■ **Source:** B-92+50E **Sample No.:** 1 **Elev./Depth:** 3-5'
▲ **Source:** B-92+50E **Sample No.:** 2 **Elev./Depth:** 6'
◆ **Source:** B-92+50E **Sample No.:** 6 **Elev./Depth:** 15-16.5'
▼ **Source:** B-92+50W **Sample No.:** 3 **Elev./Depth:** 7'

Remarks:
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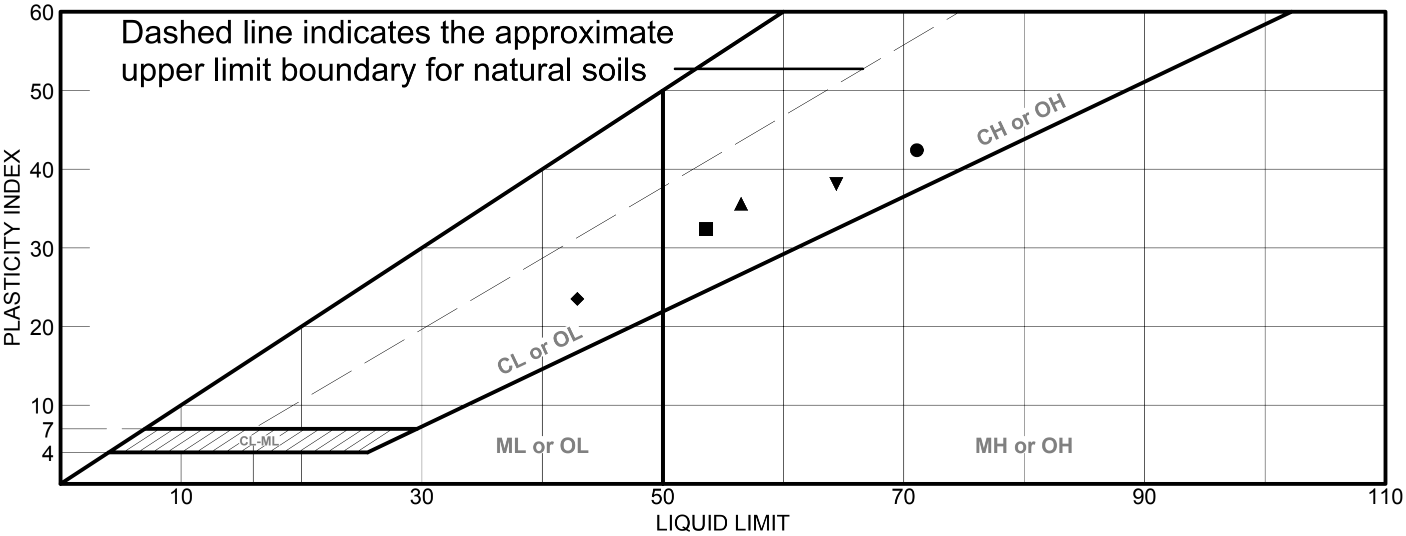
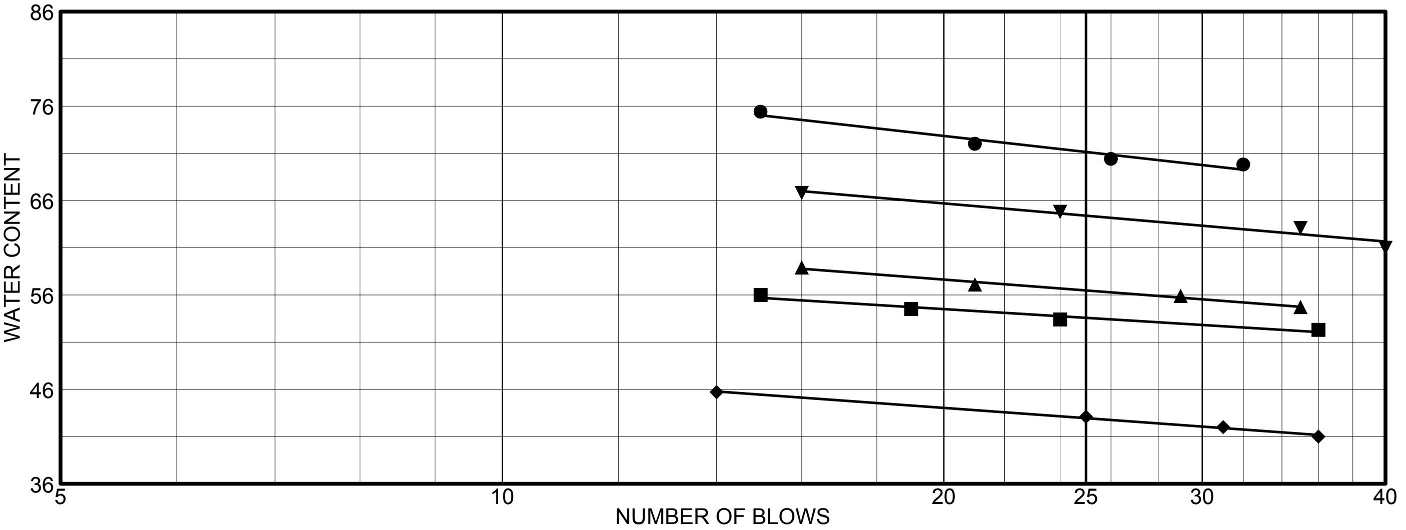
LIQUID AND PLASTIC LIMITS TEST REPORT

COOPER TESTING LABORATORY

Figure

LIQUID AND PLASTIC LIMITS TEST REPORT





	MATERIAL DESCRIPTION	LL	PL	PI	%<#40	%<#200	USCS
●	Dark Gray Fat CLAY	71.1	28.7	42.4			
■	Dark Olive Brown Fat CLAY w/ Sand	53.6	21.2	32.4			
▲	Dark Gray Fat CLAY	56.5	20.9	35.6			
◆	Dark Olive Brown Sandy Lean CLAY	42.9	19.4	23.5			
▼	Dark Gray Fat CLAY w/ Sand	64.4	26.3	38.1			

Project No. 250-051 **Client:** GEI Consultants

Project: Lower Llagas Creek - 115400

● **Source:** B-59+00W **Elev./Depth:** 4-9'
■ **Source:** B-65+00E **Elev./Depth:** 4-9'
▲ **Source:** B-78+00W **Elev./Depth:** 5-10'
◆ **Source:** B-132+50E **Elev./Depth:** 2-7'
▼ **Source:** B-92+50W **Elev./Depth:** 4-10'

Remarks:
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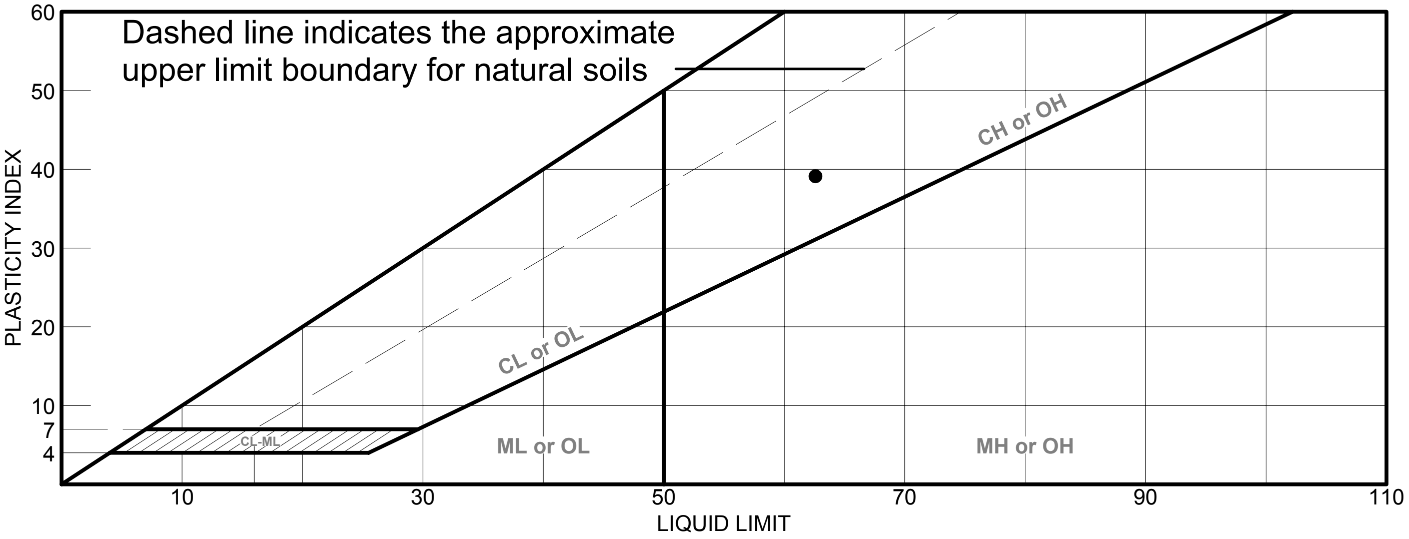
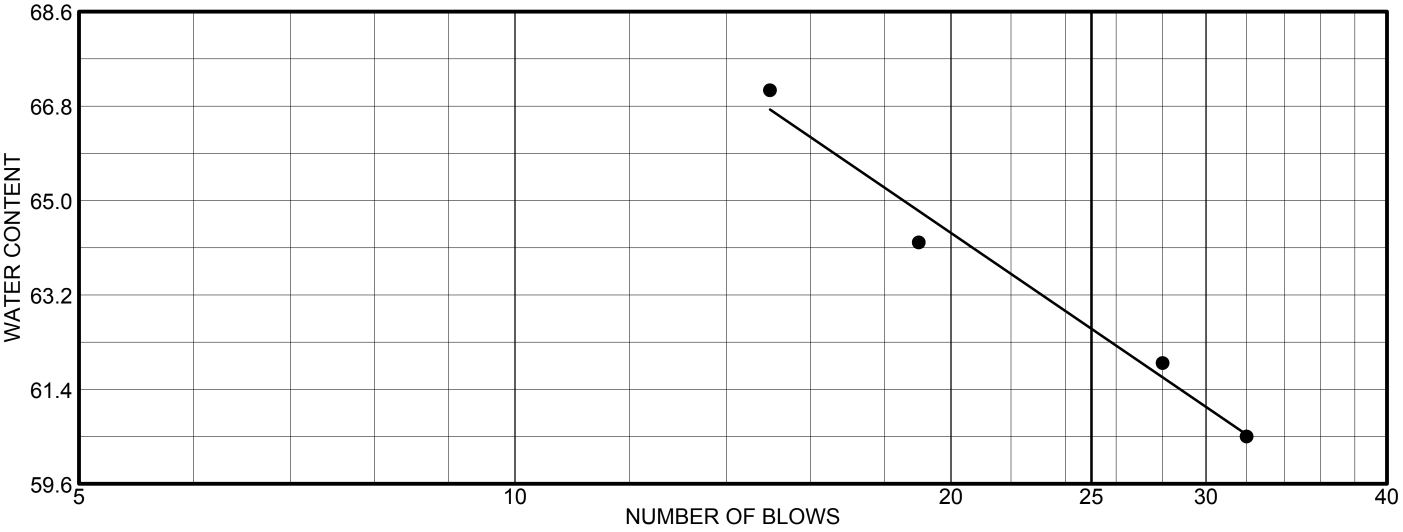
LIQUID AND PLASTIC LIMITS TEST REPORT

COOPER TESTING LABORATORY

Figure

LIQUID AND PLASTIC LIMITS TEST REPORT





	MATERIAL DESCRIPTION	LL	PL	PI	%<#40	%<#200	USCS
●	Dark Gray Fat CLAY w/ Sand	62.6	23.5	39.1			

Project No. 250-051 **Client:** GEI Consultants

Project: Lower Llagas Creek - 115400

● **Source:** B-107+00W

Remarks:

●

LIQUID AND PLASTIC LIMITS TEST REPORT

COOPER TESTING LABORATORY

Figure

COOPER
TESTING LABORATORY

Organic Content Test
ASTM D 2974-00 (Method C - 440 ^oC)

CTL JOB NO.: 250-049
CLIENT : GEI Consultants
PROJECT: Lower Llagas Creek
PROJECT NO.: 115400
DATE: 2/28/2012
BY: RU

Boring :	B-65+00E	B-59+00W	B-50+00W					
Sample :	13	11	13					
Depth (ft.):	21	20	23					
Visual Description:	Dark Gray Organic CLAY	Black Organic CLAY	Brownish Black PEAT					
Dish No.								
Dish wt., gm	77.22	80.20	77.23					
Soil, Org, Dish & H_2O, gm	161.68	167.13	170.14					
Oven Dry wt (105^oC), gm	114.78	107.87	103.56					
Furnace Dry wt. (440^oC), gm	101.96	94.41	88.74					
Moisture Content, % of Oven Dry Mass	124.9	214.2	252.9					
Organic Matter, %	34.1	48.6	56.3					

Note: ASTM provides no guidelines for including information about the organic content of a sample in the description when the wet/dry liquid limit data is not available. CTL developed the following guidelines to fill this gap:

0-5%: The organics are either not mentioned or mentioned as being "trace".
5-15%: The soil is considered as inorganic and is classified, as per ASTM 2487, with "with organics" included in the description.
15-50%: The soil is considered as organic and is described, per ASTM 2487.
> 50%: The soil is described as "Peat".

COOPER TESTING LABORATORY

Hydraulic Conductivity
ASTM D 5084
Method C: Falling Head Rising Tailwater

Job No:	250-049	**Boring:**	B-50+00W	**Date:**	02/24/12
Client:	GEI Consultants	**Sample:**		**By:**	MD/PJ
Project:	Lower Llagas Creek - 115400	**Depth, ft.:**	4-9	**Remolded:**	Target=92% of 95.4 pcf @ 27.6(OPT+2).

Visual Classification: Very Dark Gray CLAY

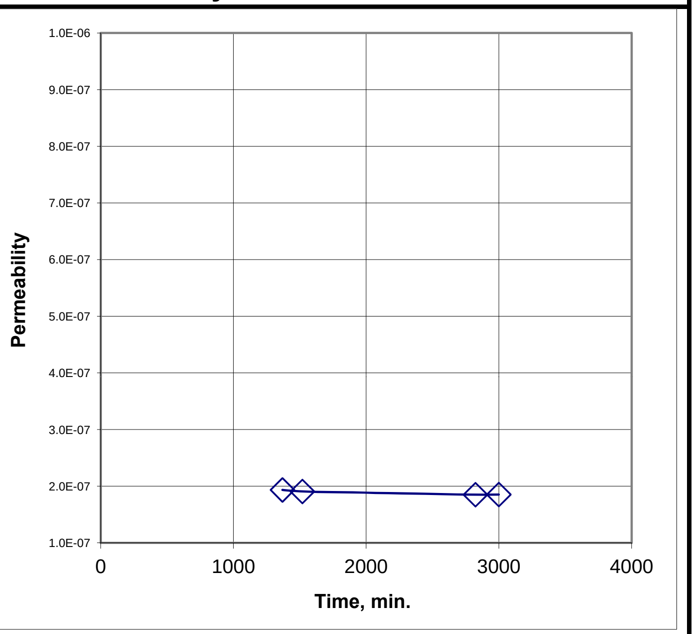
Max Sample Pressures, psi:

Cell:	Bottom	Top	Avg. Sigma3
43.5	39.5	37.5	5

B: = >0.95 **("B" is an indication of saturation)**

Max Hydraulic Gradient: = 21

Date	Minutes	Head, (in)	K,cm/sec
2/21/2012	0.00	167.66	**Start of Test**
2/22/2012	1369.00	147.66	1.9E-07
2/22/2012	1519.00	145.86	1.9E-07
2/23/2012	2823.00	130.26	1.9E-07
2/23/2012	2999.00	128.26	1.9E-07

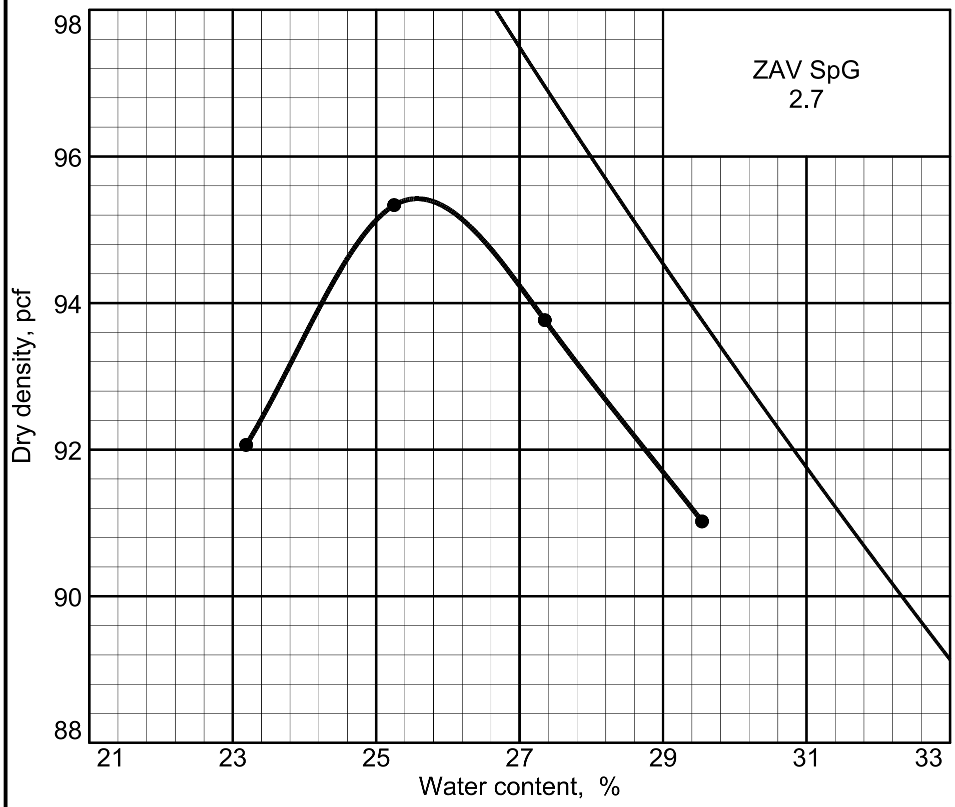


Average Hydraulic Conductivity: **2.E-07** **cm/sec**

Sample Data:	**Initial (As-Received)**		**Final (At-Test)**
Height, in	3.00		3.08
Diameter, in	2.38		2.41
Area, in2	4.43		4.56
Volume in3	13.29		14.05
Total Volume, cc	217.8		230.2
Volume Solids, cc	112.9		112.9
Volume Voids, cc	104.8		117.3
Void Ratio	0.9		1.0
Total Porosity, %	48.1		50.9
Air-Filled Porosity (θa),%	9.5		2.5
Water-Filled Porosity (θw),%	38.6		48.4
Saturation, %	80.3		95.1
Specific Gravity	2.70	Assumed	2.70
Wet Weight, gm	389.1		416.5
Dry Weight, gm	305.0		305.0
Tare, gm	0.00		0.00
Moisture, %	27.6		36.6
Wet Bulk Density, pcf	111.5		112.9
Dry Bulk Density, pcf	87.4		82.7
Wet Bulk Dens.ρb, (g/cm^3)	1.79		1.81
Dry Bulk Dens.ρb, (g/cm^3)	1.40		1.32

Remarks:

COMPACTION TEST REPORT



Curve No.

Test Specification:
ASTM D 698-00a Method B Standard

Hammer Wt.: 5.5 lb.
Hammer Drop: 12 in.
Number of Layers: three
Blows per Layer: 25
Mold Size: .03333 cu.ft.
Test Performed on Material Passing 3/8 in. **Sieve**

Soil Data

NM		**Sp.G.**	2.7
LL		**PI**	
%>3/8 in.		**%<#200**	
USCS		**AASHTO**	

TESTING DATA

	1	2	3	4	5	6
WM + WS	8.32	8.17	8.37	8.37		
WM	4.39	4.39	4.39	4.39		
WW + T #1	728.40	669.00	782.50	705.80		
WD + T #1	607.80	580.40	662.90	595.90		
TARE #1	199.60	198.30	189.30	194.10		
WW + T #2						
WD + T #2						
TARE #2						
MOISTURE	29.5	23.2	25.3	27.4		
DRY DENSITY	91.0	92.1	95.3	93.8		

TEST RESULTS

Maximum dry density = 95.4 pcf

Optimum moisture = 25.6 %

Material Description

Very Dark Gray CLAY

Project No. 250-049 **Client:** GEI Consultants
Project: Lower Llagas Creek - 115400

● **Source:** B-50+00W **Sample No.:** 22 **Elev./Depth:** 4-9'

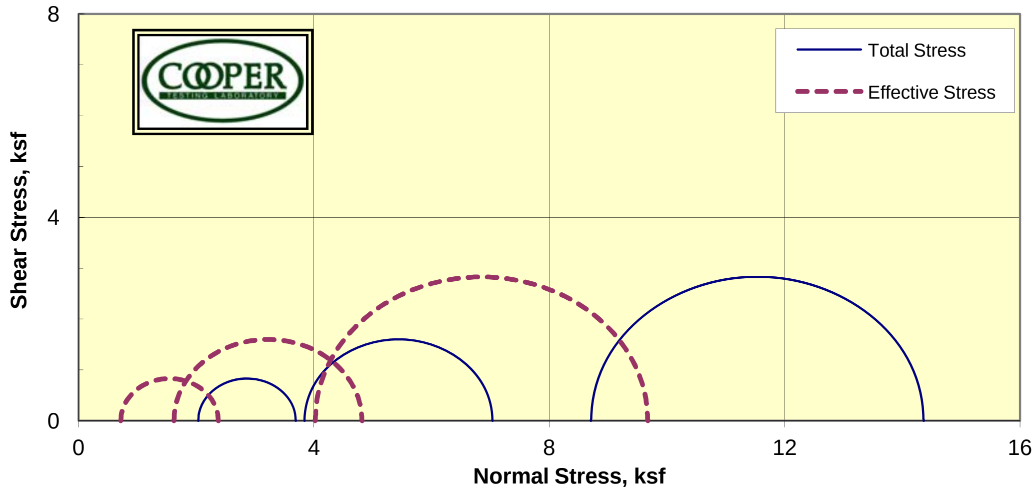
Remarks:

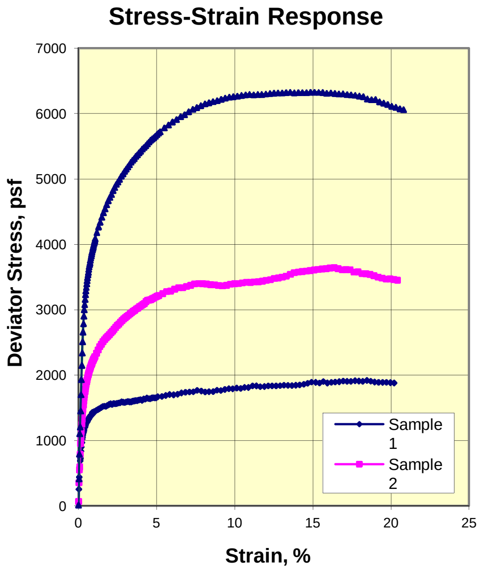
COMPACTION TEST REPORT

COOPER TESTING LABORATORY

Figure

Triaxial Consolidated Undrained with Pore Pressure
ASTM D4767





Sample:	1	2	3	4
MC, %	28.3	28.9	28.3	
DD, pcf	86.7	86.4	86.8	
Sat. %	81.2	82.1	81.1	
Void Ratio	0.943	0.950	0.941	
Diameter in	2.38	2.38	2.38	
Height, in	5.00	5.00	5.00	
	Final			
MC, %	33.4	31.1	27.5	
DD, pcf	88.6	91.6	96.7	
Sat. %	100.0	100.0	100.0	
Void Ratio	0.902	0.840	0.742	
Diameter, in	2.36	2.33	2.29	
Height, in	4.95	4.90	4.81	
Cell, psi	83.8	99.2	130.2	
BP, psi	69.7	72.5	69.7	
	Effective Stresses At:			
Strain, %	5.0	5.0	5.0	
Deviator ksf	1.658	3.197	5.656	
Excess PP	1.317	2.218	4.687	
Sigma 1	2.375	4.818	9.676	
Sigma 3	0.717	1.621	4.021	
P, ksf	1.546	3.219	6.849	
Q, ksf	0.829	1.599	2.828	
Stress Ratio	3.314	2.973	2.407	
Rate in/min	0.0003	0.0003	0.0003	

Total C	#DIV/0!	ksf
Total phi	#DIV/0!	degrees
Eff. C	#DIV/0!	ksf
Eff. Phi	#DIV/0!	degrees

Job No.: 250-049 **Date:** 2/29/2012

Client: GEI Consultants BY:DC

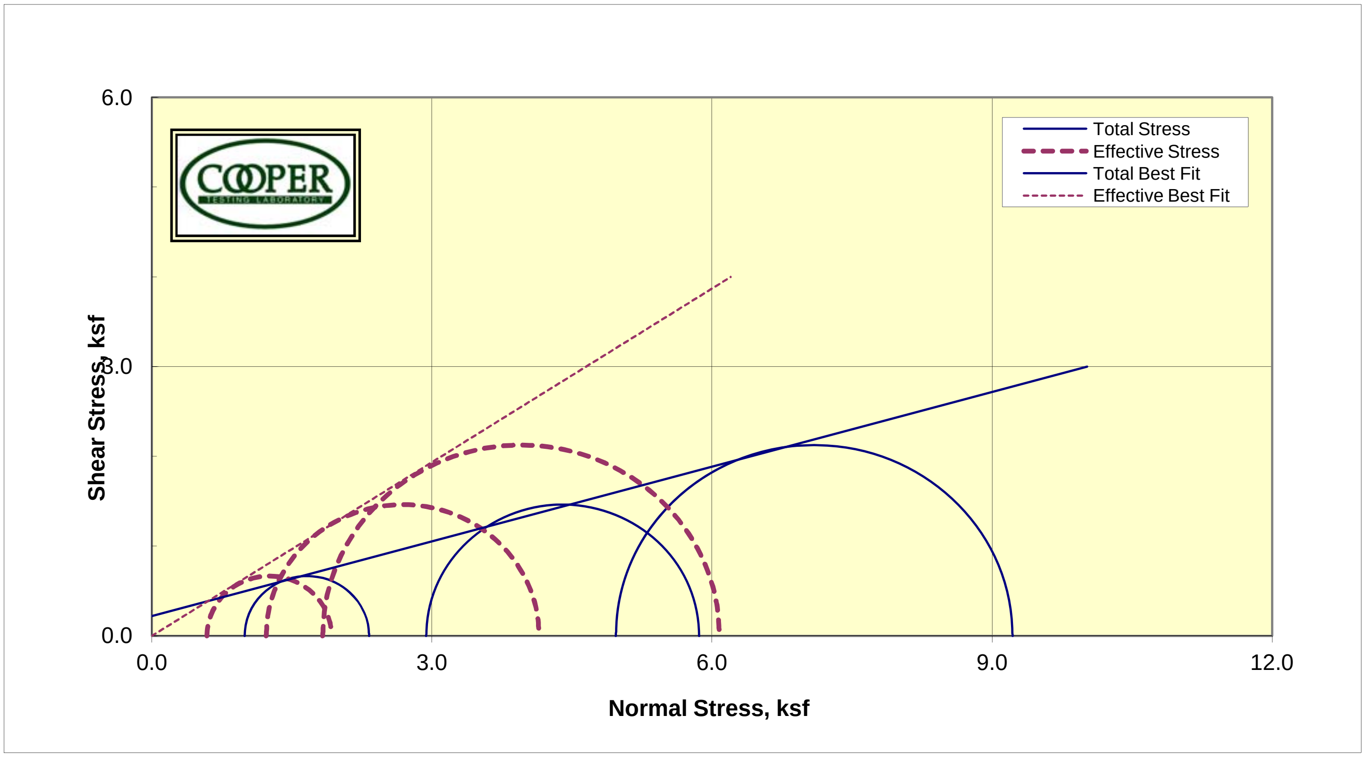
Project: Lower Llagas Creek - 115400

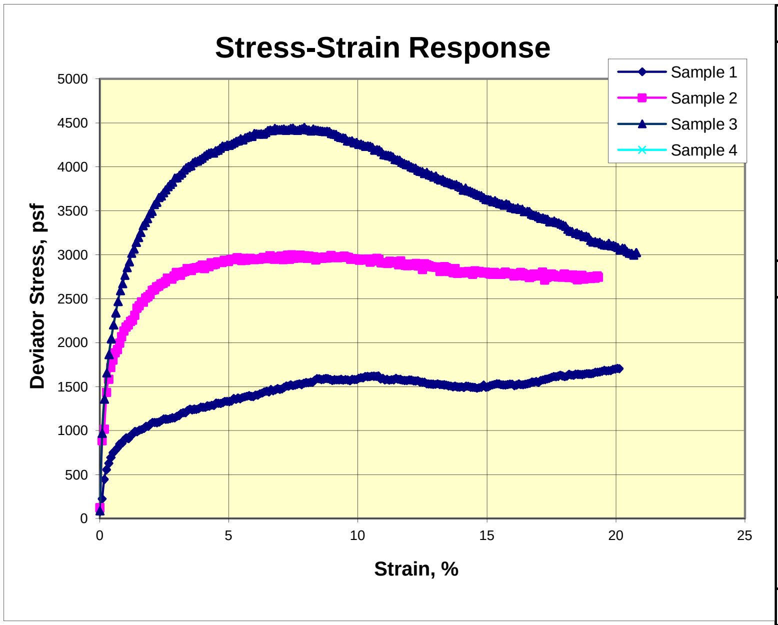
Sample 1)	B-50+00W @ 4-9'	Very Dark Gray CLAY
Sample 2)	B-50+00W @ 4-9'	Very Dark Gray CLAY
Sample 3)	B-50+00W @ 4-9'	Very Dark Gray CLAY

Possible non linear strength envelope. A linear best fit may overstate the apparent cohesion. Engineering judgment is recommended.

Triaxial Consolidated-Undrained With Pore Pressure

(ASTM D4767)





Job No.: 250-049 **Date:** 2/29/2012

Client: GEI Consultants BY:MD/DC

Project: Lower Llagas Creek - 115400

Sample 1) B-50+00W;9 @ 16-18(Tip-14) Dark Gray Fat CLAY, trace organics

Sample 2) B-50+00W;9 @ 16-18(Tip-8) Dark Gray Fat CLAY, trace organics

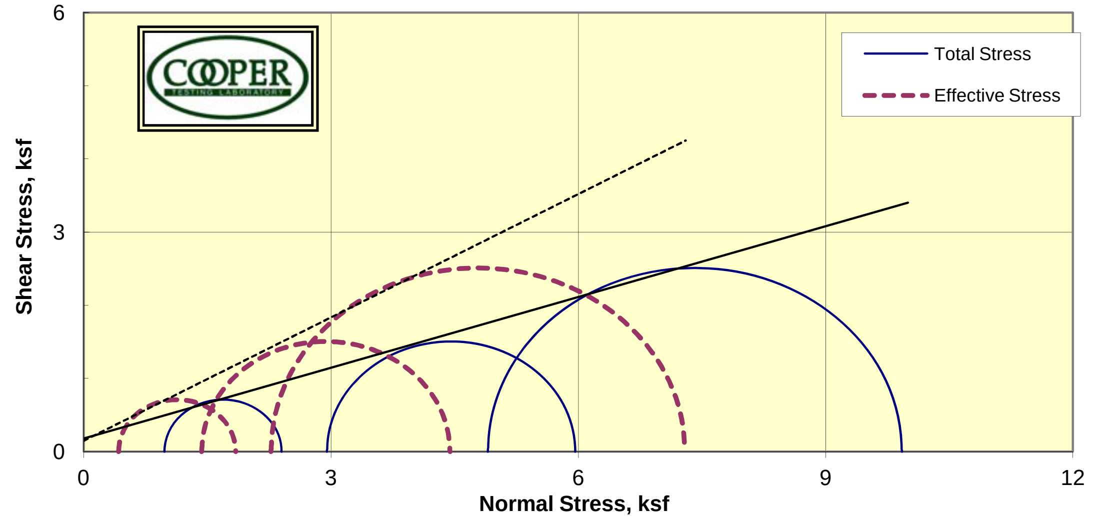
Sample 3) B-50+00W;9 @ 16-18(Tip-2) Dark Gray Fat CLAY, trace organics

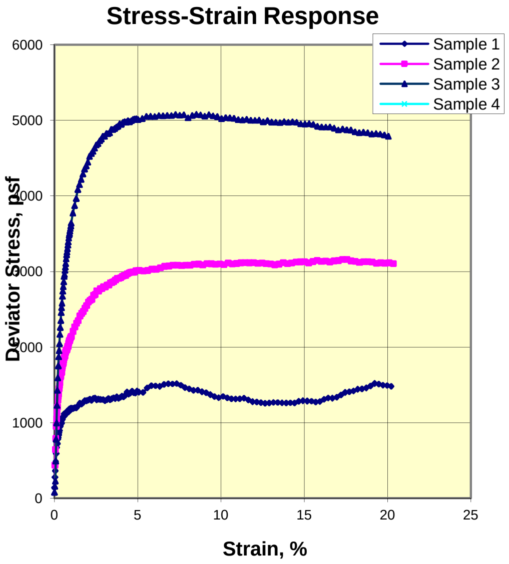
Sample 4)

REMARKS: Strengths picked at 5% strain. ***Slickensides noted @ shear zone of Sample 3.

Sample:	**1**	**2**	**3**	**4**
MC, %	44.9	53.0	71.8	
Dry Dens, pcf	75.3	67.4	56.1	
Sat. %	97.9	95.3	96.9	
Void Ratio	1.239	1.501	2.002	
Diameter in	2.87	2.87	2.87	
Height, in	5.98	5.98	5.87	
	Final			
MC, %	44.3	50.8	63.0	
Dry Dens, pcf	76.7	71.0	62.4	
Sat. %	100.0	100.0	100.0	
Void Ratio	1.196	1.371	1.701	
Diameter, in	2.85	2.81	2.75	
Height, in	5.94	5.92	5.76	
Cell, psi	55.4	69.3	83.2	
BP, psi	48.5	48.9	48.7	
	Effective Stresses At:			
Strain, %	5.0	5.0	5.0	
Deviator ksf	1.334	2.924	4.251	
Excess PP	0.403	1.714	3.139	
Sigma 1	1.924	4.148	6.080	
Sigma 3	0.590	1.224	1.829	
P, ksf	1.257	2.686	3.954	
Q, ksf	0.667	1.462	2.126	
Stress Ratio	3.259	3.389	3.325	
Rate in/min	0.0005	0.0006	0.0005	
Total C	0.2	ksf		
Total Phi	15.5	Degrees		
Eff. C	0.0	ksf		
Eff. Phi	32.8	Degrees		

Triaxial Consolidated Undrained with Pore Pressure
ASTM D4767





Sample:	1	2	3	4
MC, %	65.3	38.4	30.1	
DD, pcf	57.1	80.7	91.9	
Sat. %	90.4	95.3	97.5	
Void Ratio	1.951	1.087	0.832	
Diameter in	2.87	2.87	2.87	
Height, in	5.98	5.98	6.00	
	Final			
MC, %	68.1	37.4	28.4	
DD, pcf	59.3	83.8	95.4	
Sat. %	100.0	100.0	100.0	
Void Ratio	1.839	1.010	0.767	
Diameter, in	2.83	2.84	2.85	
Height, in	5.92	5.88	5.89	
Cell, psi	45.4	59.3	73.2	
BP, psi	38.6	38.8	39.2	
	Effective Stresses At:			
Strain, %	5.0	5.0	5.0	
Deviator ksf	1.420	3.012	5.023	
Excess PP	0.557	1.519	2.630	
Sigma 1	1.843	4.443	7.294	
Sigma 3	0.423	1.431	2.271	
P, ksf	1.133	2.937	4.783	
Q, ksf	0.710	1.506	2.512	
Stress Ratio	4.357	3.105	3.212	
Rate in/min	0.0005	0.0005	0.0005	

Job No.: 250-049 **Date:** 2/29/2012

Client: GEI Consultants BY:DC

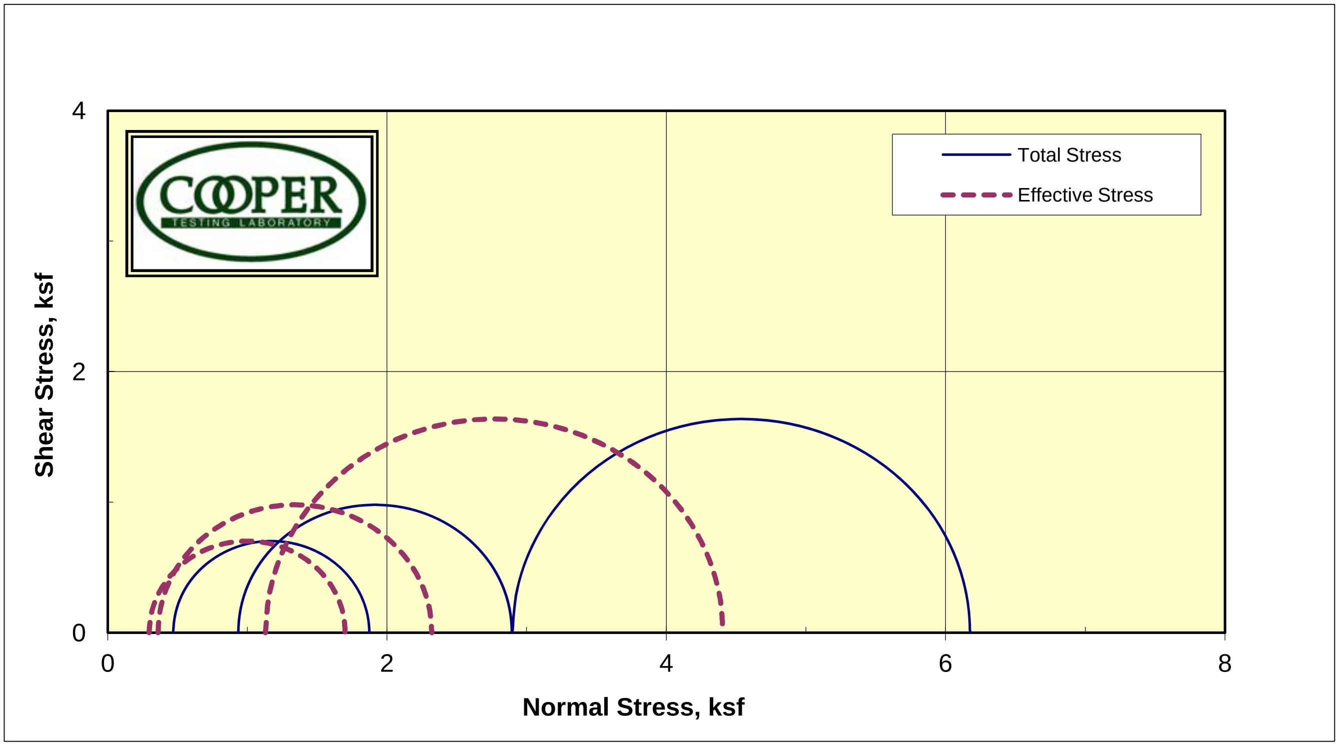
Project: Lower Llagas Creek - 115400

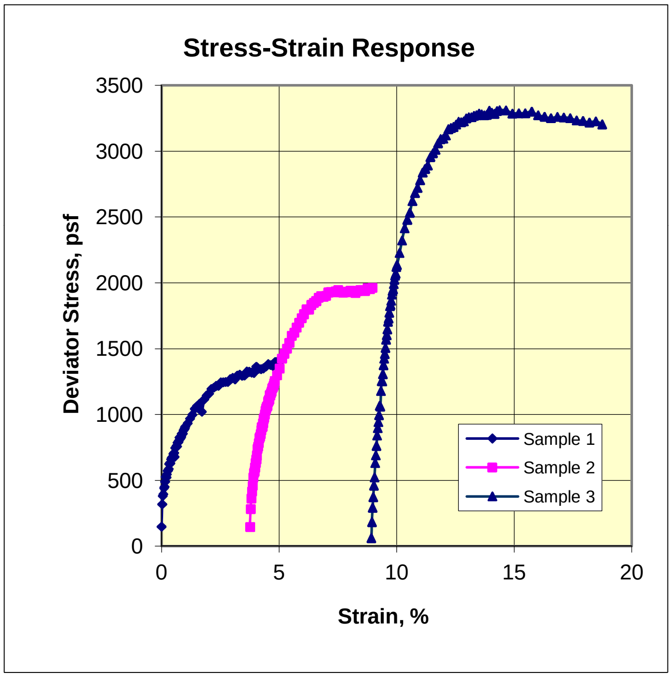
Sample 1)	B-78+00W;15 @ 25-27(Tip-21)	Very Dark Gray Lean CLAY
Sample 2)	B-78+00W;15 @ 25-27(Tip-15)	Very Dark Gray Lean CLAY
Sample 3)	B-78+00W;15 @ 25-27(Tip-9)	Very Dark Gray Lean CLAY
Sample 4)		

Remarks: Strengths picked at 5% strain. ***Slickensides noted @ shear zone of Sample 1.

Total C	**0.2**	**ksf**
Total phi	**17.8**	**degrees**
Eff. C	**0.2**	**ksf**
Eff. Phi	**29.3**	**degrees**

Triaxial Consolidated Undrained with Pore Pressure
(ASTM D4767m)





Job No.: 250-049 **Date:** 2/28/2012

Client: GEI Consultants BY:DC

Project: Lower Llagas Creek - 115400

Sample: B-92+50E;1 @ 3-5(Tip-9) Very Dark Gray Fat CLAY w/ organics grading Brown

Remarks: ** Staged Test ** Strengths at 5% strain.

*Possible non linear strength envelope. A linear best fit may overstate the apparent cohesion. Engineering judgment is recommended.

Stage	1	2	3
MC, %	83.2		
Dry Dens., pcf.	48.1		
Sat. %	89.9		
Void Ratio	2.501		
Diameter in	2.87		
Height, in	5.99		
	Final		
MC, %	89.8	86.5	78.9
Dry Dens., pcf.	48.4	49.7	52.9
Sat. %	100.0	100.0	100.0
Void Ratio	2.424	2.337	2.130
Diameter, in	2.87	2.88	2.86
Height, in	5.95	5.77	5.50
Cell, psi	52.0	55.4	69.3
BP, psi	48.7	48.9	49.2
	Effective Stresses At:		
Strain, %	5.0	5.0	5.0
Deviator ksf	1.405	1.961	3.277
Excess PP	0.172	0.574	1.768
Sigma 1	1.701	2.321	4.407
Sigma 3	0.296	0.360	1.130
P, ksf	0.998	1.340	2.769
Q, ksf	0.702	0.981	1.639
Stress Ratio	5.742	6.449	3.900
Rate in/min	0.0005	0.0005	0.0005

Total C ______ Effective C ______

Total Phi ______ Effective Phi ______

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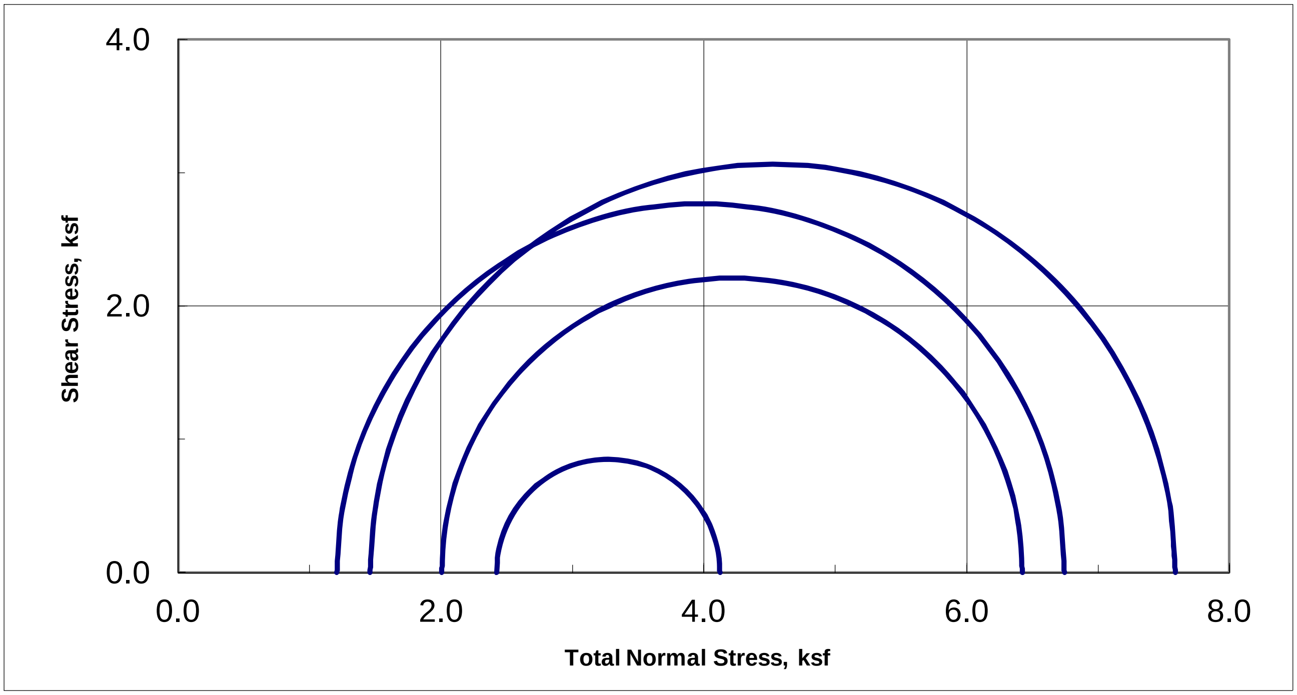
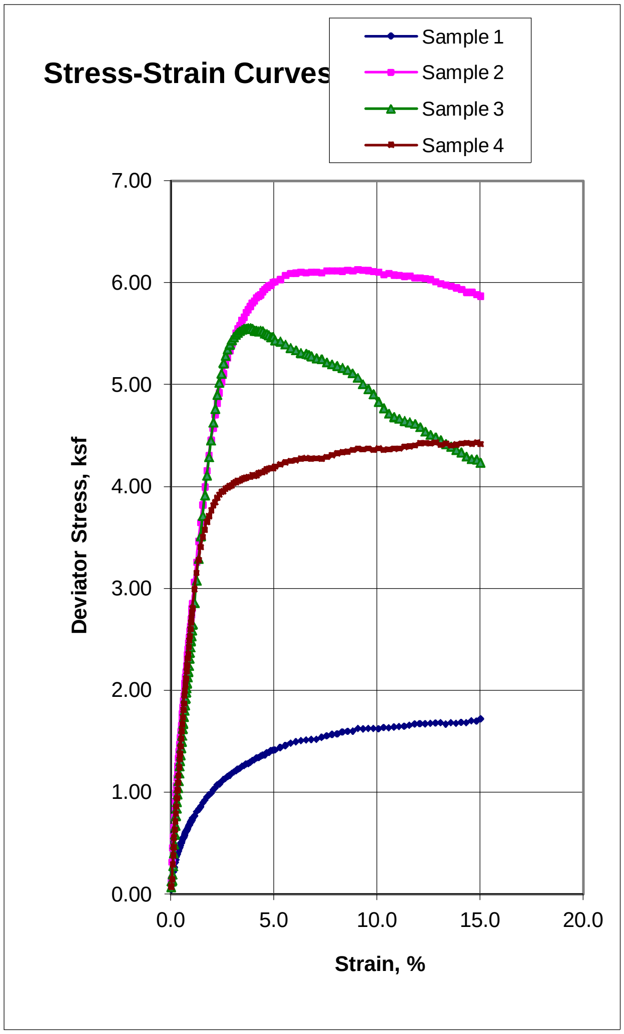
Palo Alto, CA 94303

Unconsolidated-Undrained Triaxial Test

ASTM D-2850





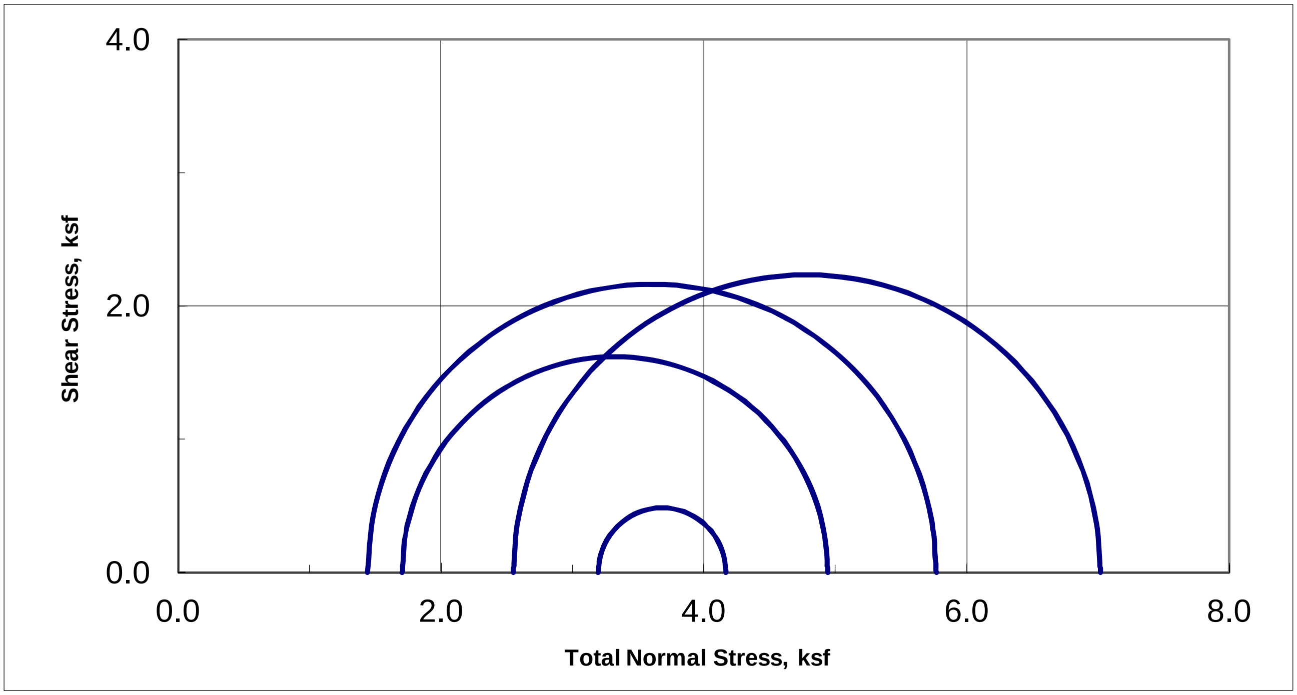
Sample Data				
	1	2	3	4
Moisture %	31.2	24.2	28.3	21.9
Dry Den,pcf	91.5	101.0	91.4	99.3
Void Ratio	0.842	0.668	0.844	0.697
Saturation %	100.0	97.9	90.4	84.8
Height in	5.99	5.99	5.97	6.00
Diameter in	2.86	2.86	2.85	2.86
Cell psi	16.8	10.1	8.4	13.9
Strain %	15.00	9.10	3.50	14.80
Deviator, ksf	1.722	6.131	5.554	4.436
Rate %/min	1.00	1.00	1.00	1.00
in/min	0.060	0.060	0.060	0.060
Job No.:	**250-049a**			
Client:	**GEI Consultants**			
Project:	**Lower Llagas Creek - 115400**			
Boring:	B-148+00E	B-132+50E	B-127+00W	B-127+00W
Sample:	8		4	6
Depth ft:	18-20(Tip-1)	10-12(Tip-1)	8-10	14-16(Tip-7)

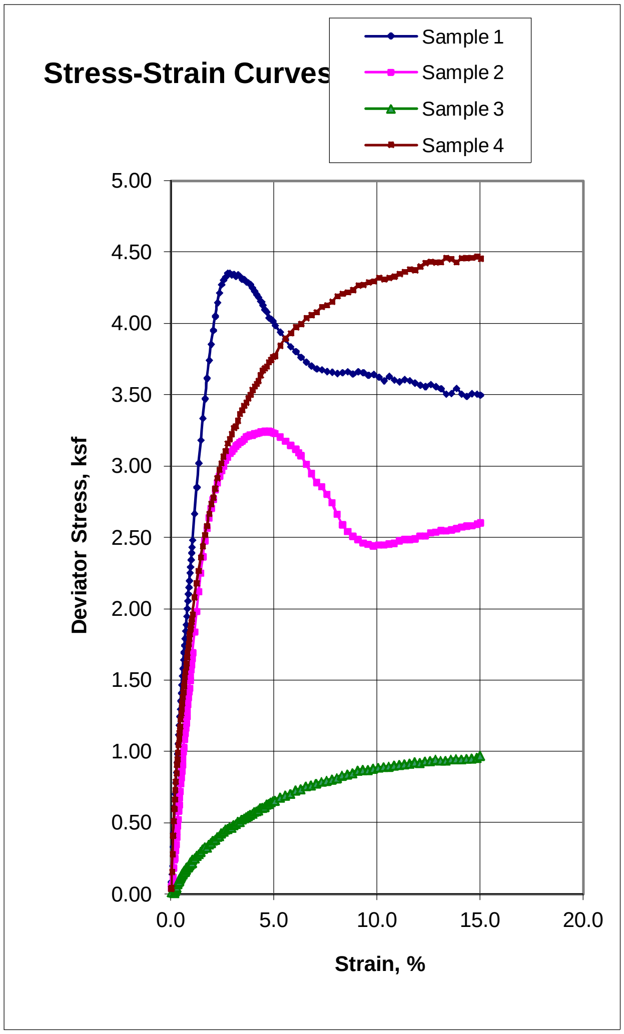
Visual Soil Description	
Sample #	
1	Dark Olive Brown Lean CLAY w/ Sand
2	Very Dark Brown Lean CLAY
3	Dark Olive Brown CLAY
4	Dark Olive Brown Lean CLAY w/ Sand*

Remarks: *near Sandy Lean CLAY.

Unconsolidated-Undrained Triaxial Test

ASTM D-2850





Sample Data				
	1	2	3	4
Moisture %	30.8	36.6	16.7	21.9
Dry Den,pcf	91.2	84.6	116.1	105.4
Void Ratio	0.847	0.993	0.452	0.598
Saturation %	98.2	99.6	99.9	98.6
Height in	5.99	5.98	5.89	5.98
Diameter in	2.86	2.87	2.88	2.87
Cell psi	10.0	11.8	22.2	17.7
Strain %	2.70	4.50	15.00	14.90
Deviator, ksf	4.354	3.247	0.971	4.468
Rate %/min	1.00	1.00	1.02	1.00
in/min	0.060	0.060	0.060	0.060
Job No.:	**250-049b**			
Client:	**GEI Consultants**			
Project:	**Lower Llagas Creek - 115400**			
Boring:	B-116+50E	B-107+00W	B-92+50W	B-65+00E
Sample:	5	6	16	11
Depth ft:	10-12(Tip-1)	12-14(Tip-4)	24-26	16-18

Visual Soil Description

Sample #	
1	Very Dark Greenish Gray Fat CLAY
2	Very Dark Gray Fat CLAY
3	Dark Olive Brown Silty, Clayey SAND w/Gr
4	Vey Dark Bluish Gray Lean CLAY w/ Sand

Remarks:

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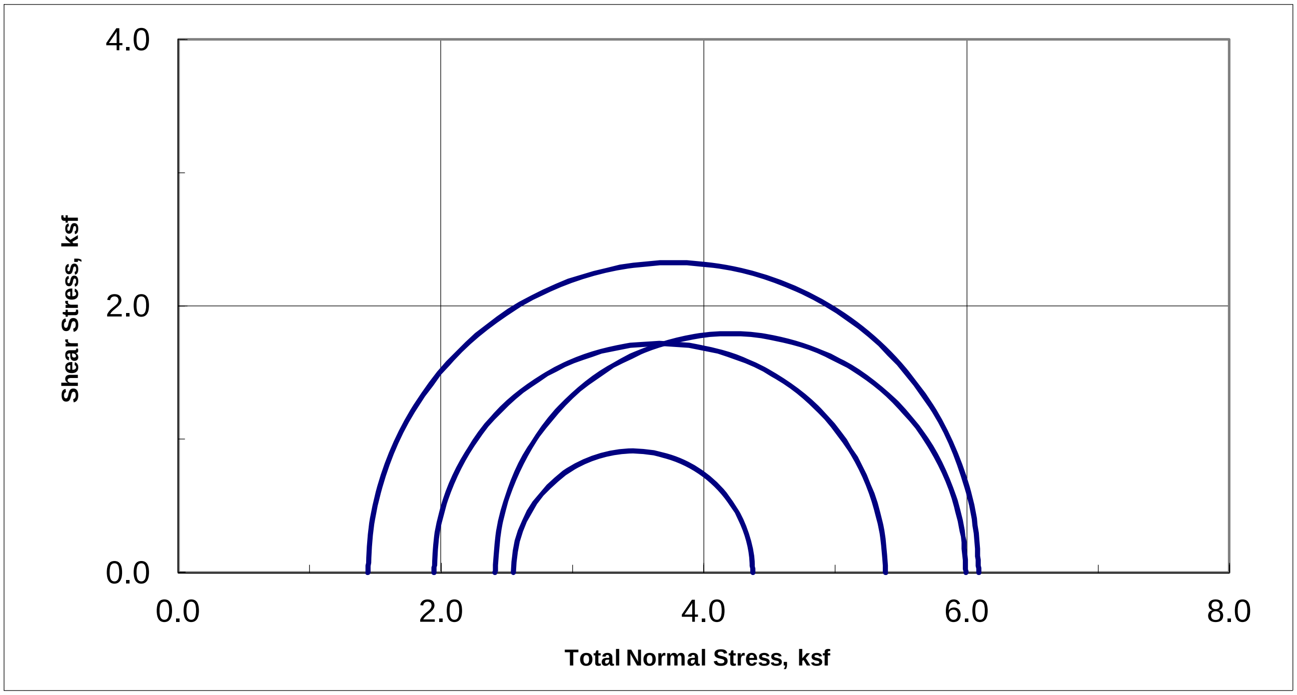
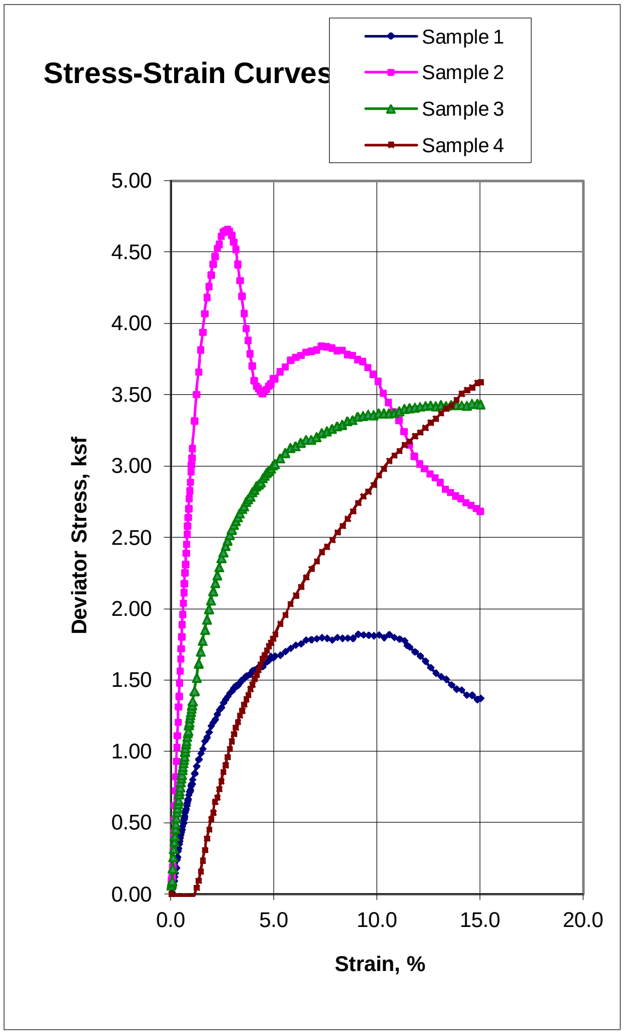
Unconsolidated-Undrained Triaxial Test

ASTM D-2850



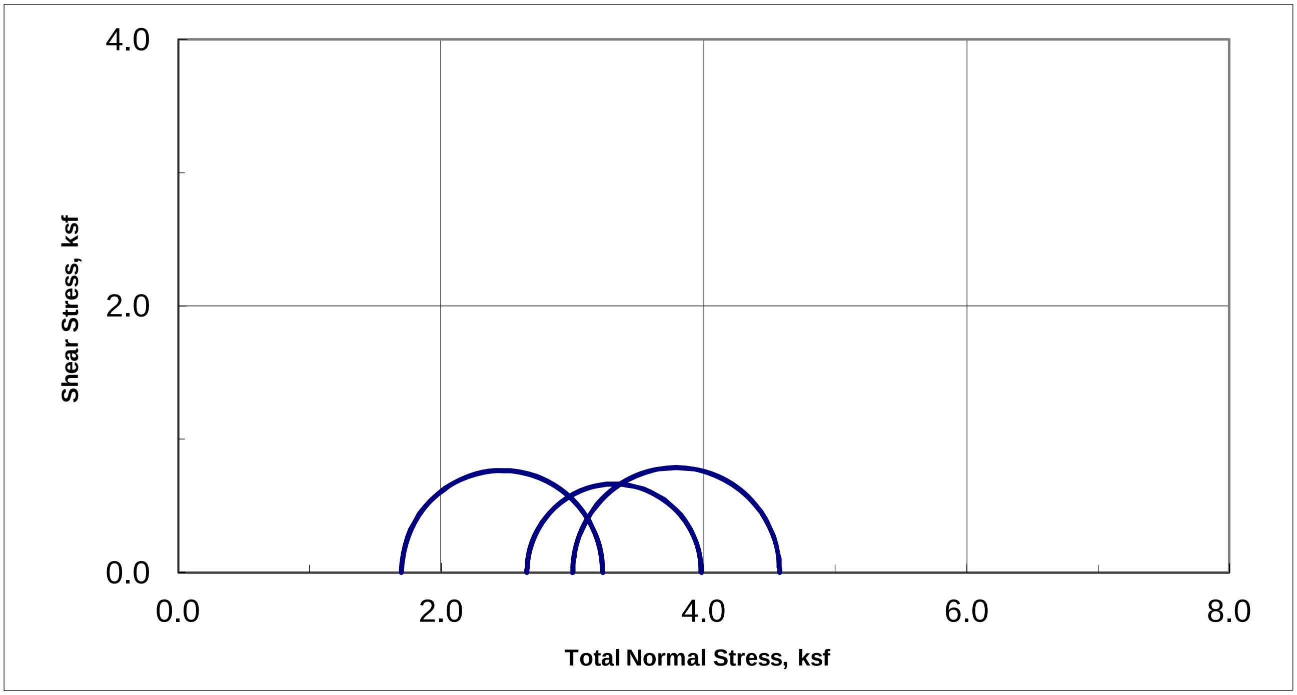


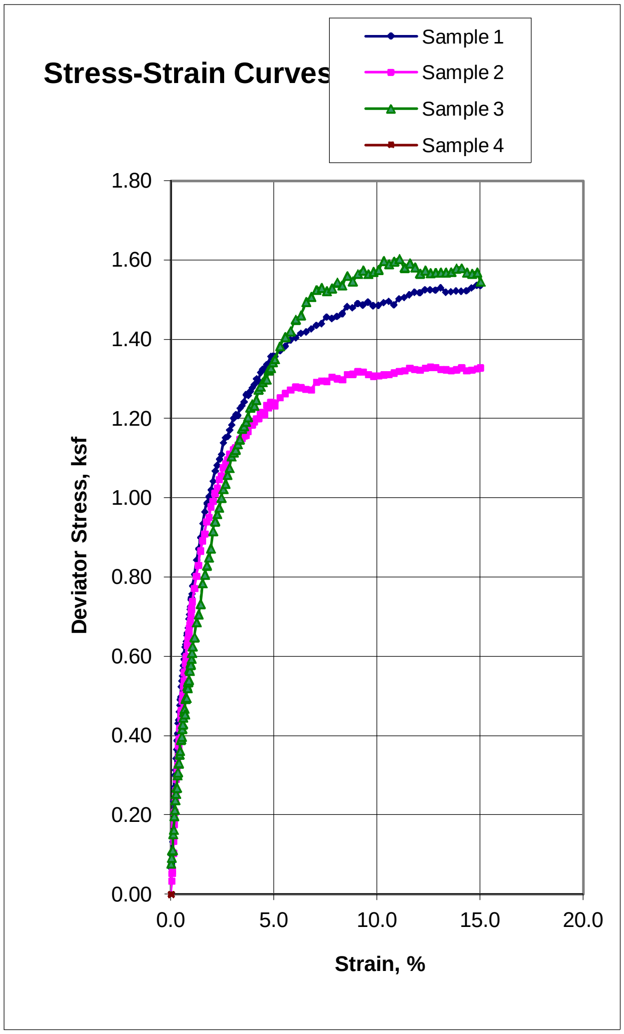
Sample Data				
	1	2	3	4
Moisture %	71.7	32.7	22.5	193.9
Dry Den,pcf	54.9	89.5	102.7	22.9
Void Ratio	2.069	0.883	0.641	6.352
Saturation %	93.5	100.0	94.8	82.4
Height in	5.05	5.99	5.99	5.08
Diameter in	2.41	2.87	2.87	2.40
Cell psi	17.7	10.0	13.5	16.7
Strain %	9.10	2.70	14.60	15.00
Deviator, ksf	1.823	4.661	3.438	3.588
Rate %/min	1.00	0.84	0.84	0.99
in/min	0.050	0.050	0.050	0.050
Job No.:	**250-049c**			
Client:	**GEI Consultants**			
Project:	**Lower Llagas Creek - 115400**			
Boring:	B-65+00E	B-59+00W	B-59+00W	B-59+00W
Sample:	13	5	8	11
Depth ft:	21	10-12	14-16(Tip-4)	20

Visual Soil Description	
Sample #	
1	Dark Gray Organic CLAY
2	Very Dark Greenish Gray CLAY
3	Very Dark Bluish Gr Lean Cl SAND w/ Grave
4	Black Organic CLAY

Remarks: *Slickensides noted @ shear zone of sample 1.

Unconsolidated-Undrained Triaxial Test
ASTM D-2850





Sample Data

	1	2	3	4
Moisture %	37.3	62.9	92.5	
Dry Den,pcf	83.7	62.4	46.2	
Void Ratio	1.014	1.701	2.647	
Saturation %	99.4	99.9	94.3	
Height in	6.00	5.99	5.06	
Diameter in	2.87	2.86	2.41	
Cell psi	11.8	18.4	20.8	
Strain %	14.80	11.60	10.30	
Deviator, ksf	1.537	1.330	1.603	
Rate %/min	1.00	1.00	1.18	
in/min	0.060	0.060	0.060	
Job No.:	**250-049d**			
Client:	**GEI Consultants**			
Project:	**Lower Llagas Creek - 115400**			
Boring:	B-50+00W	B-50+00W	B-50+00W	
Sample:	7	11	14	
Depth ft:	12-14(Tip-1)	20-22(Tip-4)	25(Tip-1)	

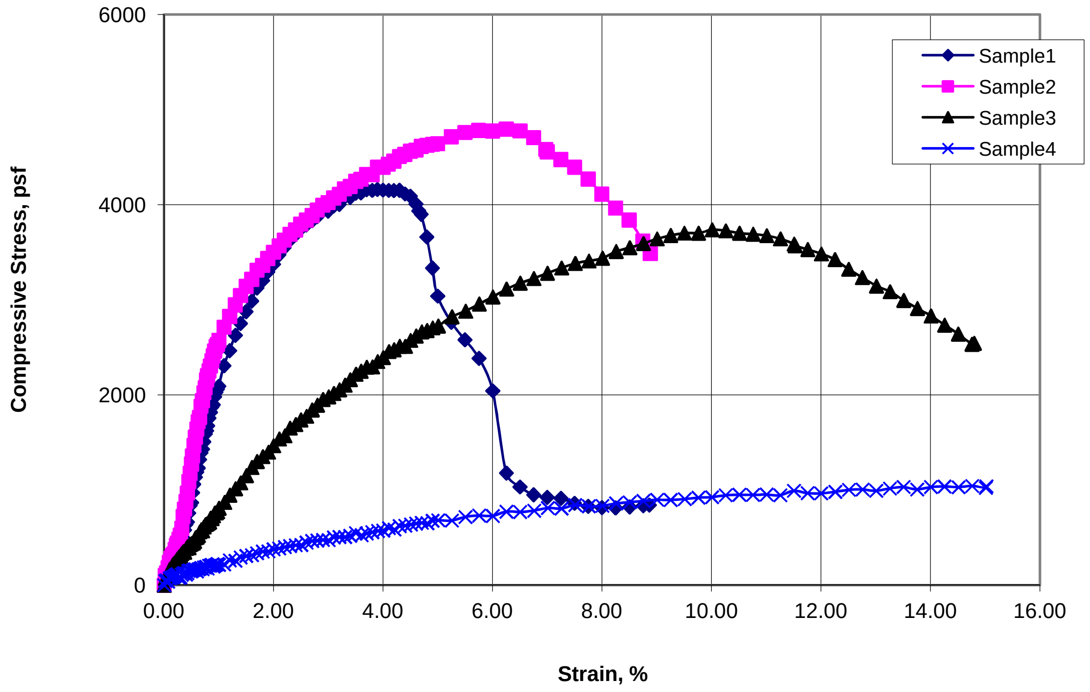
Visual Soil Description

Sample #	
1	Very Dark Bluish Gray Lean CLAY w/ Sand
2	Dark Gray Fat CLAY w/ organics
3	Very Dark Bluish Gray Elastic SILT w/ organi
4	

Remarks:

Unconfined Compressive Strength

ASTM D2166



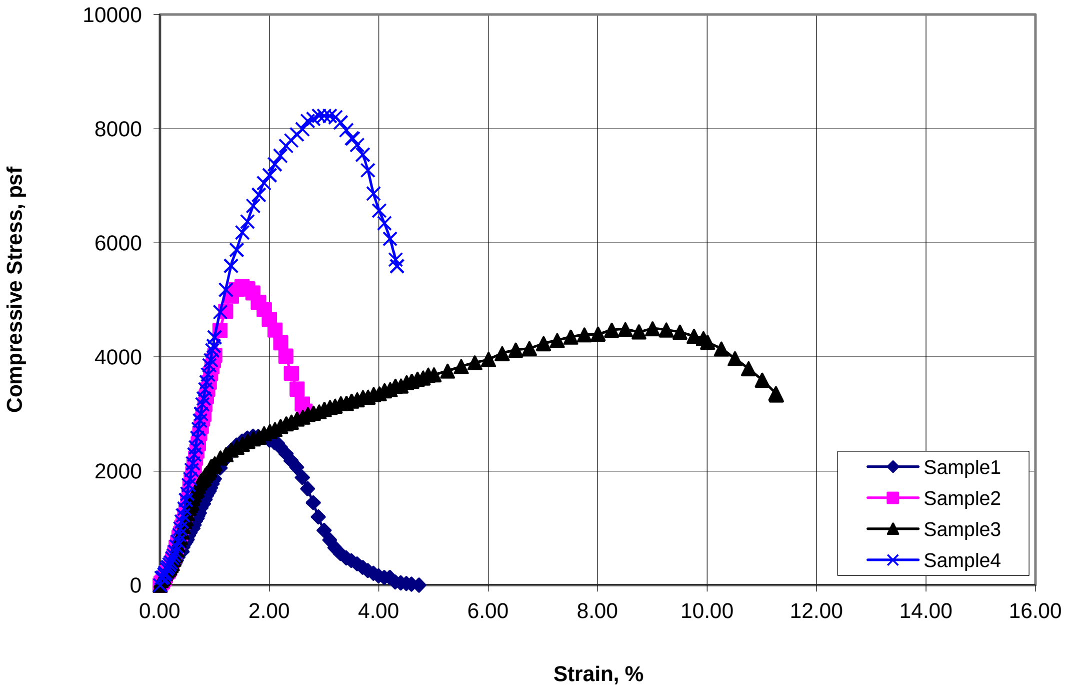
Sample No.:	1	2	3	4	
Unconfined Compressive Strength, psf	4162	4796	3738	1043	
Unconfined Compressive Strength, psi	28.9	33.3	26.0	7.2	
Undrained Shear Strength, psf	2081	2398	1869	522	
Failure Strain, %	3.9	6.2	10.0	14.8	
Strain Rate, % per minute	1.0	1.0	1.0	1.0	
Strain Rate, inches/minute	0.05	0.05	0.05	0.05	
Moisture Content, %	33.0	24.4	25.5	23.6	
Dry Density, pcf	85.7	100.0	99.5	102.6	
Saturation, %	92.1	96.1	99.2	99.0	
Void Ratio	0.967	0.686	0.694	0.643	
Specimen Diameter, inches	2.415	2.405	2.405	2.400	
Specimen Height, inches	5.01	5.00	5.02	5.00	
Height to Diameter Ratio	2.1	2.1	2.1	2.1	
Assumed Specific Gravity	2.70	2.70	2.70	2.70	

Sample Location				
	Boring	**Sample**	**Depth, ft.**	**Soil Description**
1	B-148+00E	3	6	Dark Olive Brown Fat CLAY
2	B-141+00W	7	11	Olive Brown Sandy CLAY
3	B-132+50E	3	7	Dark Olive Brown CLAY w/ Sand
4	B-132+50E	10	20	Brown Sandy CLAY

Job No.:	250-049a	**Type of Sample**	Undisturbed
Client:	GEI Consultants		
Project:	Lower Llagas Creek - 115400	Remarks:	
Date:	2/24/2012 **By:** MD/RU		

Unconfined Compressive Strength

ASTM D2166



Sample No.:	1	2	3	4	
Unconfined Compressive Strength, psf	2613	5235	4496	8227	
Unconfined Compressive Strength, psi	18.1	36.4	31.2	57.1	
Undrained Shear Strength, psf	1307	2618	2248	4114	
Failure Strain, %	1.7	1.5	9.0	3.0	
Strain Rate, % per minute	1.0	1.0	1.0	1.0	
Strain Rate, inches/minute	0.05	0.05	0.05	0.05	
Moisture Content, %	37.0	14.3	19.4	24.9	
Dry Density, pcf	72.5	101.9	109.7	93.6	
Saturation, %	75.4	58.9	97.7	84.2	
Void Ratio	1.324	0.654	0.536	0.800	
Specimen Diameter, inches	2.395	2.405	2.405	2.395	
Specimen Height, inches	5.00	5.00	5.00	5.06	
Height to Diameter Ratio	2.1	2.1	2.1	2.1	
Assumed Specific Gravity	2.70	2.70	2.70	2.70	

Sample Location				
	Boring	Sample	Depth, ft.	Soil Description
1	B-132+00W	3	6	Dark Olive Brown Fat CLAY
2	B-127+00W	3	6	Olive Brown Lean Clayey SAND, trace Gravel
3	B-116+50E	11	20	Olive Sandy Lean CLAY
4	B-107+00W	3	6	Dark Grayish Sandy Fat CLAY w/ Gravel

Job No.:	250-049b	Type of Sample	Undisturbed
Client:	GEI Consultants		
Project:	Lower Llagas Creek - 115400		
Date:	2/24/2012 By: MD/RU		

Remarks:

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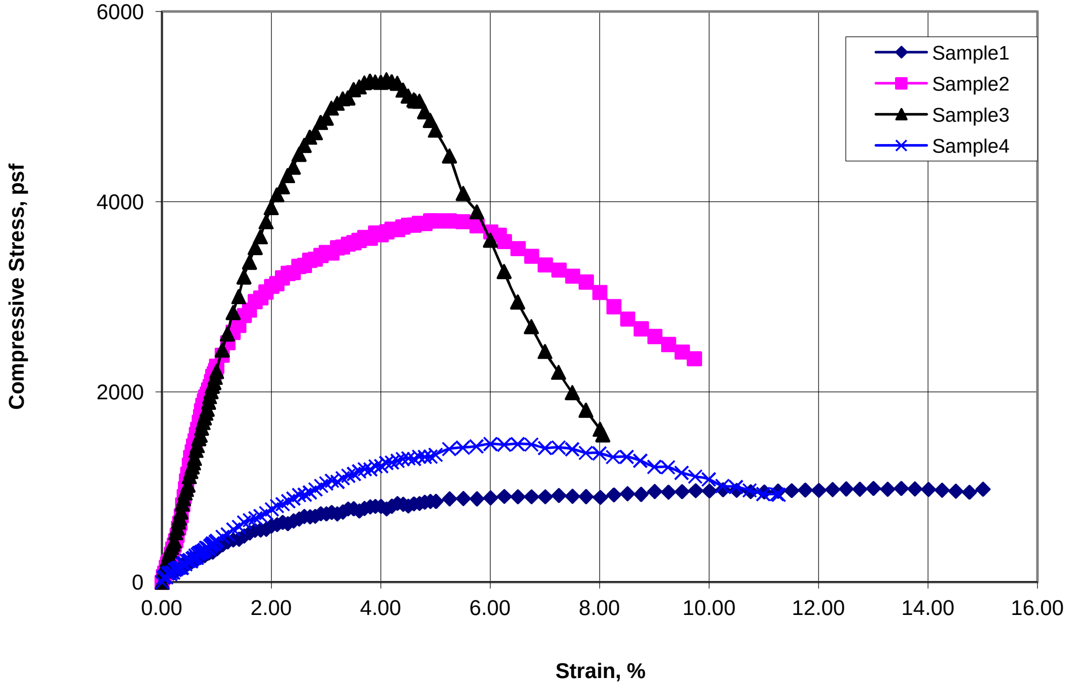
Unconfined Compressive Strength

ASTM D2166



Sample No.:	1	2	3	4	
Unconfined Compressive Strength, psf	987	3801	5286	1453	
Unconfined Compressive Strength, psi	6.9	26.4	36.7	10.1	
Undrained Shear Strength, psf	493	1900	2643	727	
Failure Strain, %	13.5	4.9	4.1	6.0	
Strain Rate, % per minute	1.0	1.0	1.0	1.0	
Strain Rate, inches/minute	0.05	0.05	0.05	0.05	
Moisture Content, %	54.2	26.4	28.4	28.5	
Dry Density, pcf	68.2	95.3	90.9	95.1	
Saturation, %	99.5	92.7	89.9	99.7	
Void Ratio	1.471	0.768	0.854	0.773	
Specimen Diameter, inches	2.420	2.420	2.400	2.405	
Specimen Height, inches	5.02	4.96	4.99	5.01	
Height to Diameter Ratio	2.1	2.0	2.1	2.1	
Assumed Specific Gravity	2.70	2.70	2.70	2.70	

Sample Location				
	Boring	**Sample**	**Depth, ft.**	**Soil Description**
1	B-92+50E	2	6	Very Dark Gray Fat CLAY
2	B-92+50W	1	3	Dark Grayish Brown CLAY w/ Sand
3	B-92+50W	3	7	Dark Gray CLAY w/ Sand, trace Gravel
4	B-92+50W	11	22	Greenish Gray Fat CLAY w/ Sand, trace Gravel

Job No.:	250-049c	**Type of Sample**	Undisturbed
Client:	GEI Consultants		
Project:	Lower Llagas Creek - 115400	Remarks:	
Date:	2/24/2012 **By:** MD/RU		

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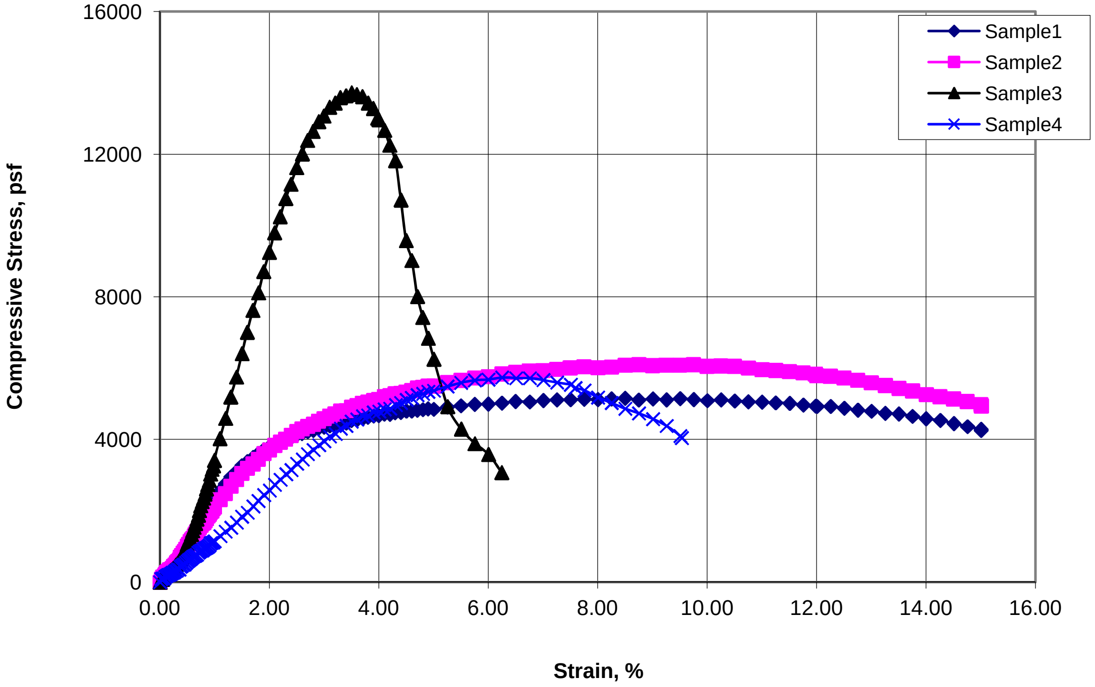
Unconfined Compressive Strength

ASTM D2166



Sample No.:	1	2	3	4	
Unconfined Compressive Strength, psf	5157	6100	13726	5740	
Unconfined Compressive Strength, psi	35.8	42.4	95.3	39.9	
Undrained Shear Strength, psf	2579	3050	6863	2870	
Failure Strain, %	8.5	9.7	3.5	6.3	
Strain Rate, % per minute	1.0	1.0	1.0	1.0	
Strain Rate, inches/minute	0.05	0.05	0.05	0.05	
Moisture Content, %	31.1	24.7	13.9	25.1	
Dry Density, pcf	90.7	101.0	111.8	92.9	
Saturation, %	97.8	99.9	73.9	83.2	
Void Ratio	0.858	0.668	0.508	0.815	
Specimen Diameter, inches	2.410	2.400	2.410	2.390	
Specimen Height, inches	5.00	4.99	5.02	5.00	
Height to Diameter Ratio	2.1	2.1	2.1	2.1	
Assumed Specific Gravity	2.70	2.70	2.70	2.70	

Sample Location				
	Boring	**Sample**	**Depth, ft.**	**Soil Description**
1	B-78+00W	5	7	Dark Gray Fat CLAY
2	B-78+00W	11	17	Black Fat CLAY w/ Sand, trace Gravel
3	B-65+00E	11	2-2.5	Olive Brown CLAY
4	B-65+00E	7	9	Dark Greenish Gray CLAY

Job No.:	250-049d	**Type of Sample**	Undisturbed
Client:	GEI Consultants		
Project:	Lower Llagas Creek - 115400	Remarks:	
Date:	2/24/2012 **By:** MD/RU		

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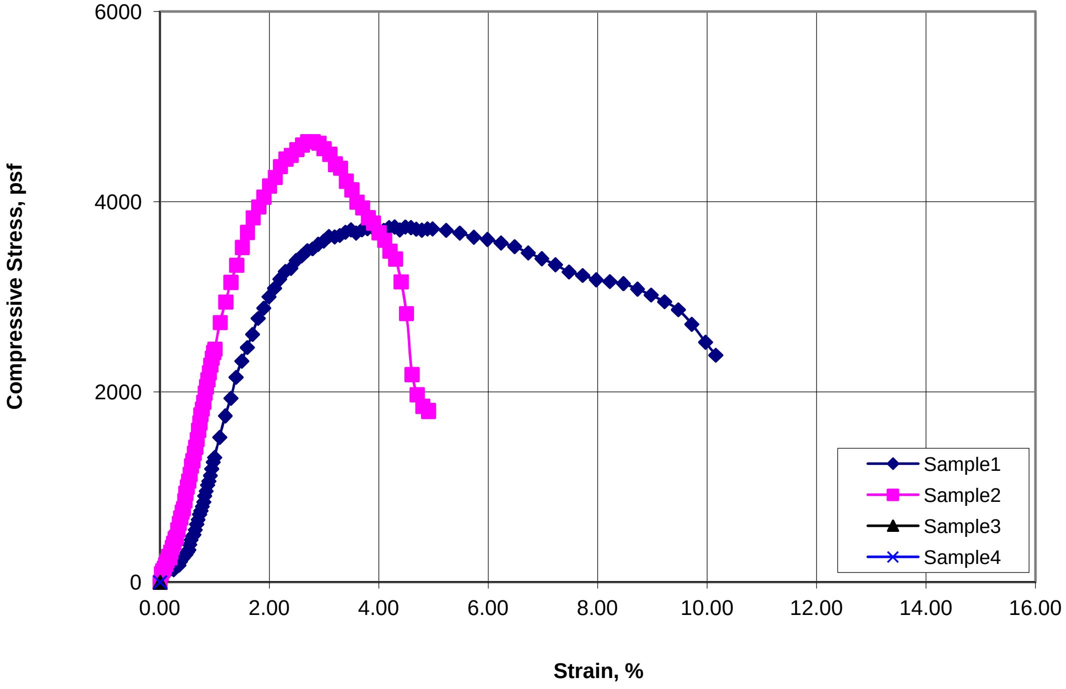
Unconfined Compressive Strength

ASTM D2166



Sample No.:	1	2	3	4	
Unconfined Compressive Strength, psf	3737	4634			
Unconfined Compressive Strength, psi	25.9	32.2			
Undrained Shear Strength, psf	1868	2317			
Failure Strain, %	4.3	2.7			
Strain Rate, % per minute	1.0	1.0			
Strain Rate, inches/minute	0.05	0.05			
Moisture Content, %	27.3	25.9			
Dry Density, pcf	96.8	91.7			
Saturation, %	99.4	83.6			
Void Ratio	0.741	0.838			
Specimen Diameter, inches	2.435	2.400			
Specimen Height, inches	5.00	4.99			
Height to Diameter Ratio	2.1	2.1			
Assumed Specific Gravity	2.70	2.70			

Sample Location				
	Boring	**Sample**	**Depth, ft.**	**Soil Description**
1	B-65+00E	9	13	Dark Gray CLAY
2	B-59+00W	3	6	Dark Olive Brown Fat CLAY w/ Sand
3				
4				

Job No.:	250-049e	**Type of Sample**	Undisturbed
Client:	GEI Consultants		
Project:	Lower Llagas Creek - 115400	Remarks:	
Date:	2/24/2012 **By:** MD/RU		

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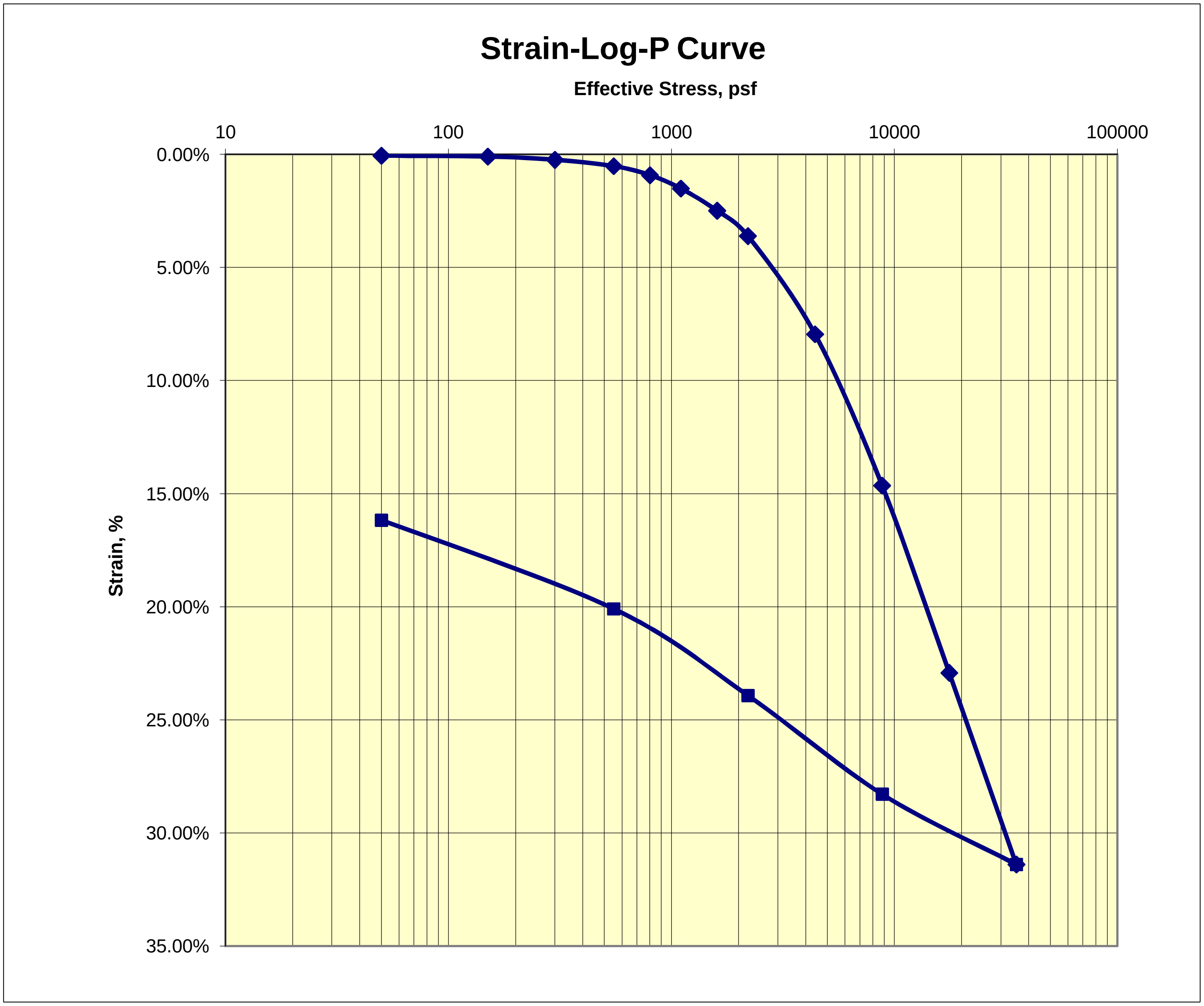
Consolidation Test
ASTM D2435

Job No.:	250-049	**Boring:**	B-50+00W	**Run By:**	MD
Client:	GEI Consultants	**Sample:**	11	**Reduced:**	PJ
Project:	Lower Llagas Creek - 115400	**Depth, ft.:**	20-22	**Checked:**	PJ/DC
Soil Type:	Dark Gray Fat CLAY w/ organics			**Date:**	2/28/2012

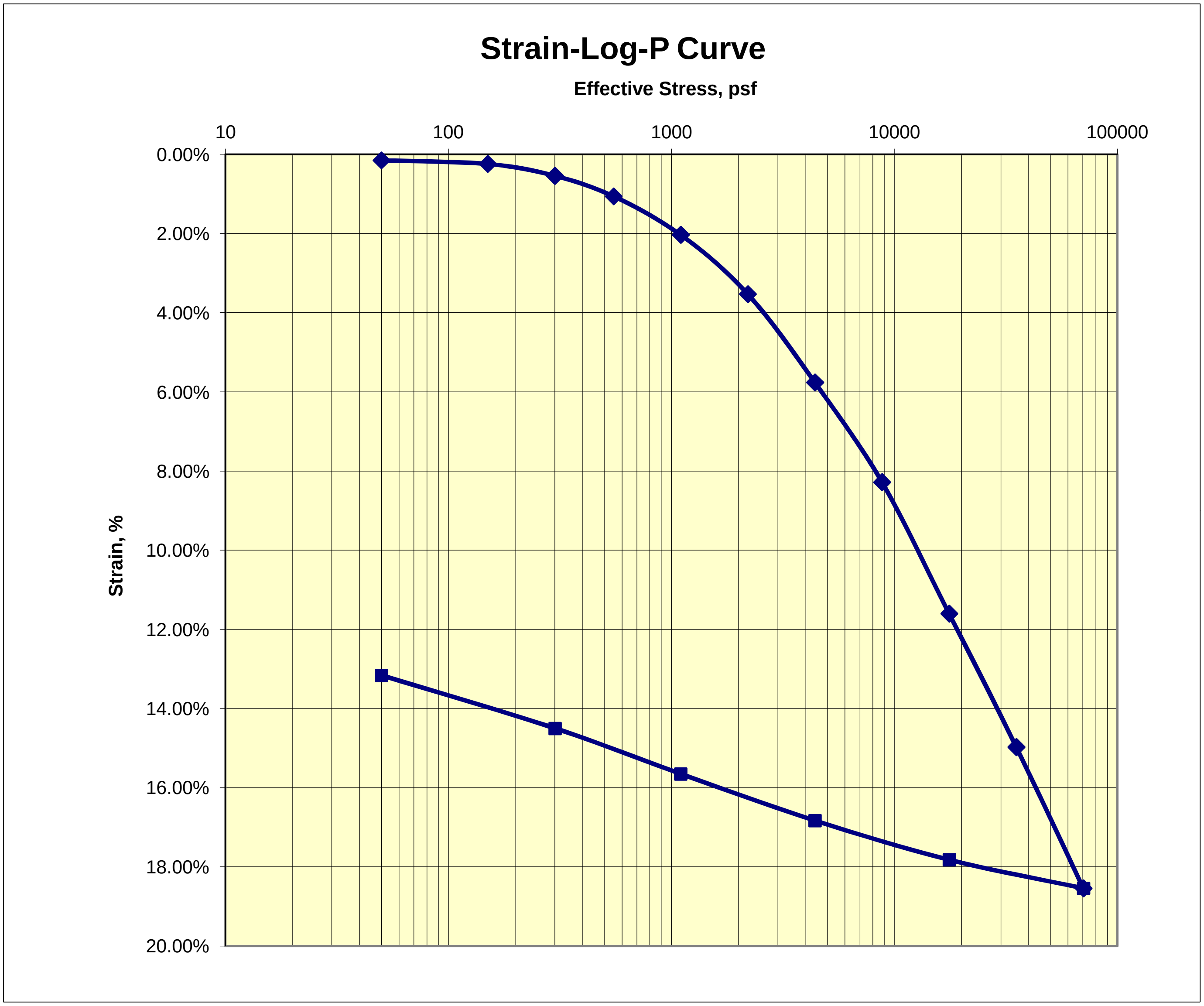


Ass. Gs = 2.8	**Initial**	**Final**
Moisture %:	69.6	55.7
Dry Density, pcf:	57.8	68.3
Void Ratio:	2.024	1.558
% Saturation:	96.3	100

Remarks:

Consolidation Test
ASTM D2435

Job No.:	250-049	**Boring:**	B-59+00W	**Run By:**	MD
Client:	GEI Consultants	**Sample:**	8	**Reduced:**	PJ
Project:	Lower Llagas Creek - 115400	**Depth, ft.:**	14-16	**Checked:**	PJ/DC
Soil Type:	Dark Gray Lean Clayey SAND w/ Gravel			**Date:**	2/28/2012



Ass. Gs = 2.7	**Initial**	**Final**
Moisture %:	20.6	17.1
Dry Density, pcf:	102.8	115.4
Void Ratio:	0.639	0.460
% Saturation:	86.9	100

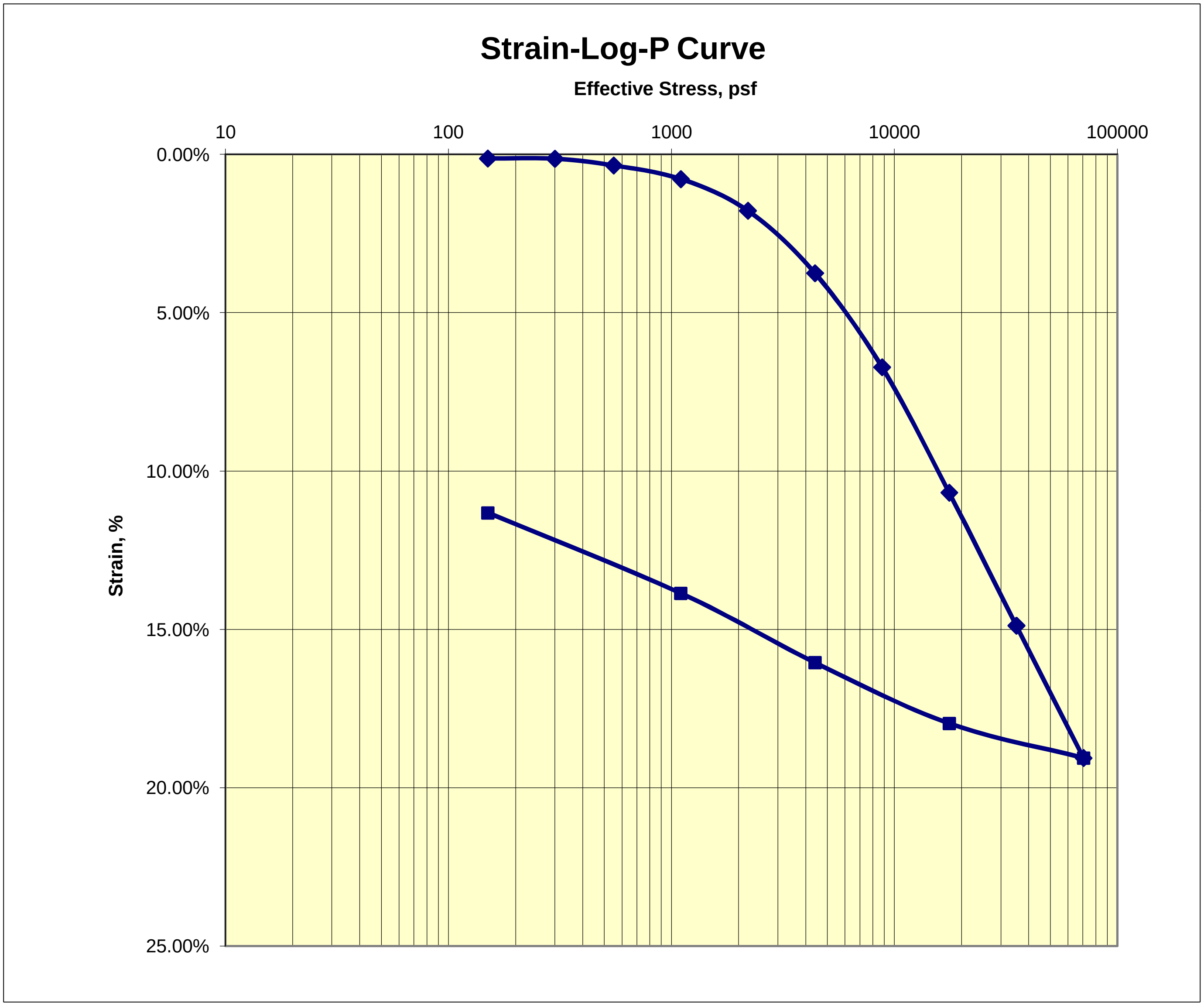
Remarks:

COOPER TESTING LABORATORY

Consolidation Test

ASTM D2435

Job No.:	250-049	**Boring:**	B-78+00W	**Run By:**	MD
Client:	GEI Consultants	**Sample:**	15	**Reduced:**	PJ
Project:	Lower Llagas Creek - 115400	**Depth, ft.:**	25-27(ip-3)	**Checked:**	PJ/DC
Soil Type:	Very Dark Gray Lean CLAY, trace Sand			**Date:**	2/27/2012



Ass. Gs = 2.8	**Initial**	**Final**
Moisture %:	25.5	20.5
Dry Density, pcf:	98.5	111.1
Void Ratio:	0.775	0.573
% Saturation:	92.1	100

Remarks:

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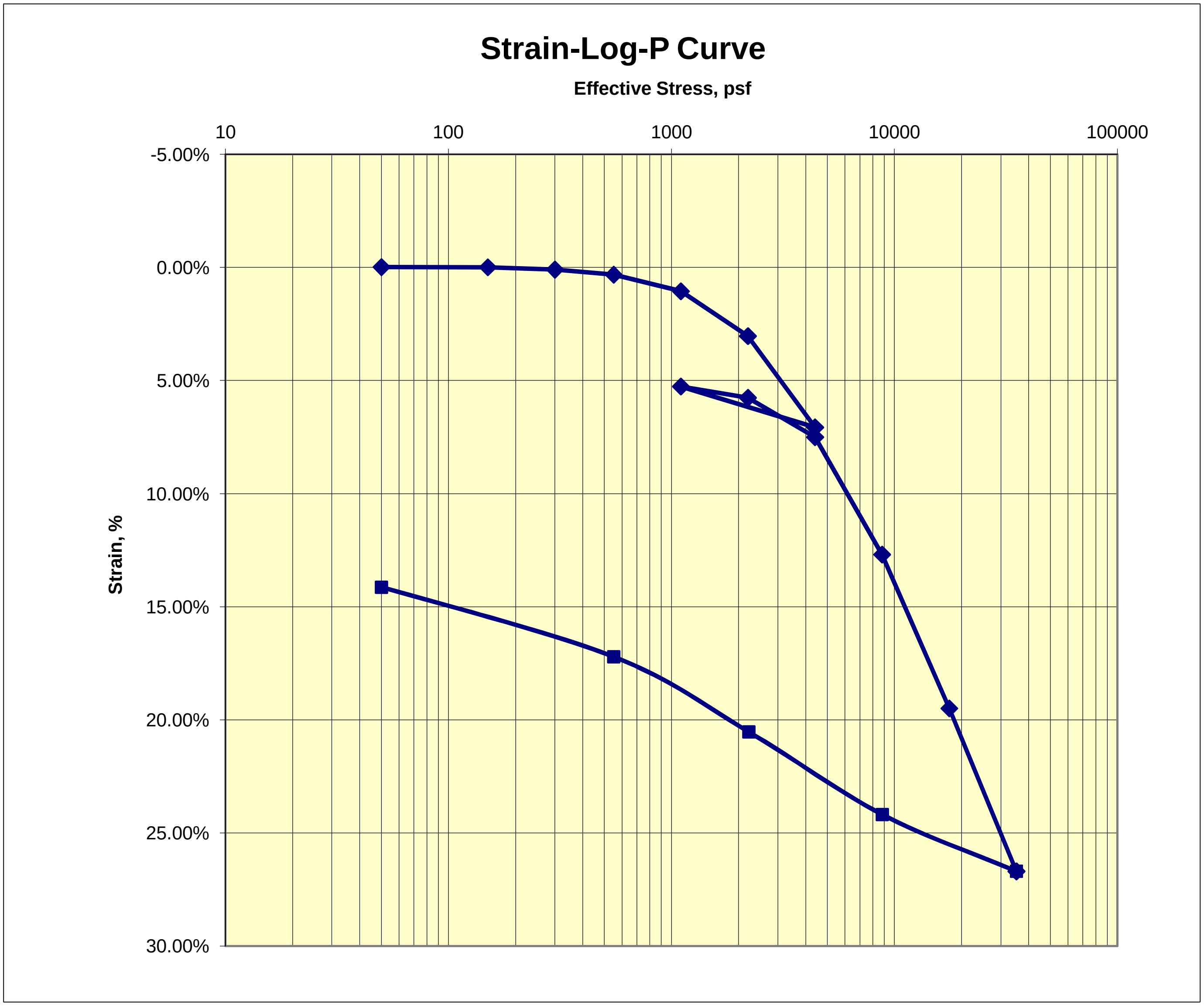
Consolidation Test
ASTM D2435

Job No.:	250-049	**Boring:**	B-92+50E	**Run By:**	MD
Client:	GEI Consultants	**Sample:**	1	**Reduced:**	PJ
Project:	Lower Llagas Creek - 115400	**Depth, ft.:**	3-5(Tip-3)	**Checked:**	PJ/DC
Soil Type:	Very Dark Gray Fat CLAY w/ organics			**Date:**	2/28/2012

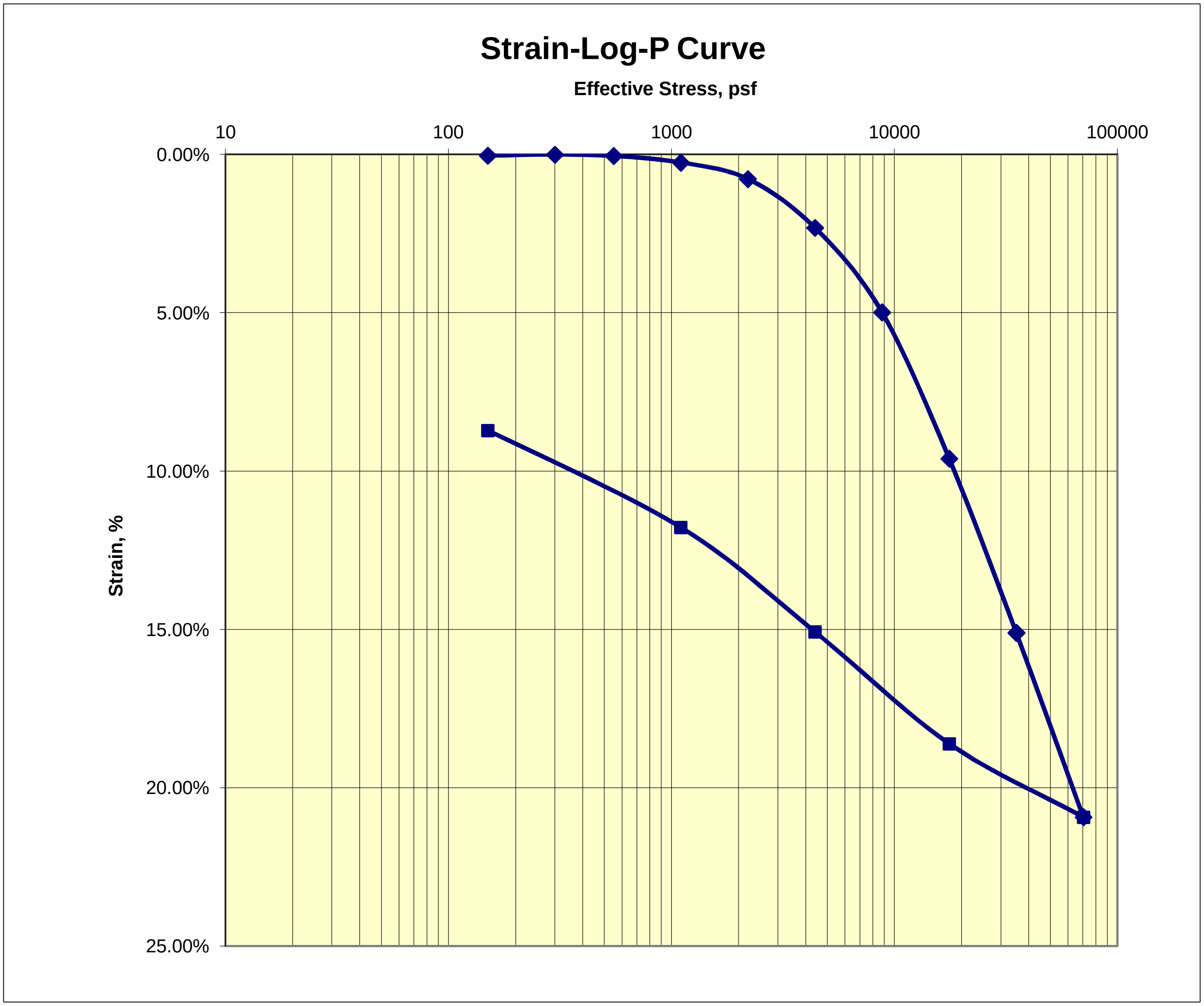


Ass. Gs = 2.75	**Initial**	**Final**
Moisture %:	63.1	52.9
Dry Density, pcf:	60.5	70.0
Void Ratio:	1.836	1.454
% Saturation:	94.5	100

Remarks:

Consolidation Test
ASTM D2435

Job No.:	250-049	**Boring:**	B-107+00W	**Run By:**	MD
Client:	GEI Consultants	**Sample:**	6	**Reduced:**	PJ
Project:	Lower Llagas Creek - 115400	**Depth, ft.:**	12-14	**Checked:**	PJ/DC
Soil Type:	Dark Gray Fat CLAY			**Date:**	2/27/2012



Ass. Gs = 2.8	**Initial**	**Final**
Moisture %:	33.9	30.7
Dry Density, pcf:	86.3	94.1
Void Ratio:	1.025	0.858
% Saturation:	92.5	100

Remarks:

Summary of Environmental Testing Results (Curtis Tompkins)

	Sample No.		1		2		3		4		5		6		7		8		9		10		11		12		13		14		15	
	Sample ID (Lab ID)	**[STLC Lab ID]**	**B-50+00W (1+2) (234035-001)**	[235268-001]	**B-59+00W (1+2) (234035-002)**	[235268-002]	**B-65+00E (1, 2, 3) (234035-003)**	-	**B-127+00W (1, 2) (234035-004)**	[235268-005]	**B-141+00W (1, 2) (234035-005)**	[235268-004]	**B-166+50E (1, 2) (234035-006)**	[235268-003]	**B-132+00W (1, 2) (234035-007)**	[235268-007]	**B-173+50W (1, 2) (234035-008)**	[235268-006]	**B-107+00W (1, 2, 3) (234035-009)**	[235268-009]	**B-92+50E (1, 2, 3) (234035-010)**	-	**B-116+50E (1, 2, 3) (234035-011)**	[235268-008]	**B-92+50W (1, 2) (234035-012)**	[235268-010]	**B-78+00W (1, 2) (234035-013)**	[235268-011]	**B-132+50E (1, 2) (234035-014)**	-	**B-148+00E (1, 2) (234035-015)**	[235268-012]
TEST TYPE	EPA Analysis	Units	Result	RL	Result	RL	Result	RL	Result	RL	Result	RL	Result	RL	Result	RL	Result	RL	Result	RL	Result	RL	Result	RL	Result	RL	Result	RL	Result	RL	Result	RL
TPHG/MTBE/BTEX[1]																																
Gasoline C7-C12	8015B	(mg/Kg)	ND	1.1	ND	0.95	ND	1.0	ND	0.98	ND	1.0	ND	1.1	ND	1.1	ND	0.91	ND	1.1	ND	0.99	ND	1.1	ND	0.94	ND	0.96	ND	0.99	ND	0.94
MTBE	8021B	(µg/Kg)	ND	22	ND	19	ND	20	ND	20	ND	21	ND	22	ND	22	ND	18	ND	22	ND	20	ND	21	ND	19	ND	19	ND	20	ND	19
Benzene	8021B	(µg/Kg)	ND	5.4	ND	4.8	ND	5.0	ND	4.9	ND	5.2	ND	5.4	ND	5.4	ND	4.5	ND	5.5	ND	5.0	ND	5.3	ND	4.7	ND	4.8	ND	5.0	ND	4.7
Toluene	8021B	(µg/Kg)	ND	5.4	ND	4.8	ND	5.0	ND	4.9	ND	5.2	ND	5.4	ND	5.4	ND	4.5	ND	5.5	ND	5.0	ND	5.3	ND	4.7	ND	4.8	ND	5.0	ND	4.7
Ethylbenzene	8021B	(µg/Kg)	ND	5.4	ND	4.8	ND	5.0	ND	4.9	ND	5.2	ND	5.4	ND	5.4	ND	4.5	ND	5.5	ND	5.0	ND	5.3	ND	4.7	ND	4.8	ND	5.0	ND	4.7
m,p-Xylenes	8021B	(µg/Kg)	ND	5.4	ND	4.8	ND	5.0	ND	4.9	ND	5.2	ND	5.4	ND	5.4	ND	4.5	ND	5.5	ND	5.0	ND	5.3	ND	4.7	ND	4.8	ND	5.0	ND	4.7
o-Xylene	8021B	(µg/Kg)	ND	5.4	ND	4.8	ND	5.0	ND	4.9	ND	5.2	ND	5.4	ND	5.4	ND	4.5	ND	5.5	ND	5.0	ND	5.3	ND	4.7	ND	4.8	ND	5.0	ND	4.7
Diesel and Motor Oil[2]																																
Diesel C10-C24	8015B	(mg/Kg)	12 Y	0.99	5.2 Y	1.0	130 Y	1.0	13 Y	1.0	ND	1.0	1.2 Y	0.99	2.3 Y	1.0	1.5 Y	1.0	5.7 Y	1.0	12 Y	1.0	2.9 Y	1.0	24 Y	20	13 Y	10	160 Y	1.0	8.9 Y	1.0
Motor Oil C24-C36	8015B	(mg/Kg)	50	5.0	35	5.0	25	5.0	47	5.0	ND	5.0	5.1	5.0	15	5.0	6.0	5.0	45	5.0	9.5	5.0	20	5.0	230	100.0	96	50.0	8.0	5.0	45	5.0
Organochlorine Pesticides[3]																																
alpha-BHC	8081A	(µg/Kg)	ND	1.7	ND	1.7	ND	1.7	ND	1.7	ND	1.7	ND	1.7	ND	1.7	ND	1.7	ND	1.7	ND	1.7	ND	1.7	ND	5.1	ND	1.7	ND	1.7	ND	1.7
beta-BHC	8081A	(µg/Kg)	ND	1.7	ND	1.7	ND	1.7	ND	1.7	ND	1.7	ND	1.7	ND	1.7	ND	1.7	ND	1.7	ND	1.7	ND	1.7	ND	5.1	ND	1.7	ND	1.7	ND	1.7
gamma-BHC	8081A	(µg/Kg)	ND	1.7	ND	1.7	ND	1.7	ND	1.7	ND	1.7	ND	1.7	ND	1.7	ND	1.7	ND	1.7	ND	1.7	ND	1.7	ND	5.1	ND	1.7	ND	1.7	ND	1.7
delta-BHC	8081A	(µg/Kg)	ND	1.7	ND	1.7	ND	1.7	ND	1.7	ND	1.7	ND	1.7	ND	1.7	ND	1.7	ND	1.7	ND	1.7	ND	1.7	ND	5.1	1.9 C	1.7	ND	1.7	ND	1.7
Heptachlor	8081A	(µg/Kg)	ND	1.7	ND	1.7	ND	1.7	ND	1.7	ND	1.7	ND	1.7	ND	1.7	ND	1.7	ND	1.7	ND	1.7	ND	1.7	ND	5.1	ND	1.7	ND	1.7	ND	1.7
Aldrin	8081A	(µg/Kg)	ND	1.7	ND	1.7	ND	1.7	ND	1.7	ND	1.7	ND	1.7	ND	1.7	ND	1.7	ND	1.7	ND	1.7	ND	1.7	ND	5.1	ND	1.7	ND	1.7	ND	1.7
Heptachlor epoxide	8081A	(µg/Kg)	ND	1.7	ND	1.7	ND	1.7	ND	1.7	ND	1.7	ND	1.7	ND	1.7	ND	1.7	ND	1.7	ND	1.7	ND	1.7	ND	5.1	ND	1.7	ND	1.7	ND	1.7
Endosulfan I	8081A	(µg/Kg)	ND	1.7	ND	1.7	ND	1.7	ND	1.7	ND	1.7	ND	1.7	ND	1.7	ND	1.7	ND	1.7	ND	1.7	ND	1.7	ND	5.1	ND	1.7	ND	1.7	ND	1.7
Dieldrin	8081A	(µg/Kg)	ND	3.3	ND	3.3	ND	3.3	ND	3.3	ND	3.3	ND	3.3	ND	3.3	ND	3.3	ND	3.3	ND	3.3	ND	3.3	ND	9.9	4.1	3.3	ND	3.3	3.4	3.3
4,4'-DDE	8081A	(µg/Kg)	ND	3.3	ND	3.3	ND	3.3	5.5	3.3	ND	3.3	6.6	3.3	ND	3.3	ND	3.3	ND	3.3	8.0 C	3.3	ND	3.3	ND	9.9	12	3.3	ND	3.3	15	3.3
Endrin	8081A	(µg/Kg)	ND	3.3	ND	3.3	ND	3.3	ND	3.3	ND	3.3	ND	3.3	ND	3.3	ND	3.3	ND	3.3	ND	3.3	ND	3.3	ND	9.9	ND	3.3	ND	3.3	ND	3.3
Endosulfan II	8081A	(µg/Kg)	ND	3.3	ND	3.3	ND	3.3	ND	3.3	ND	3.3	ND	3.3	ND	3.3	ND	3.3	ND	3.3	ND	3.3	ND	3.3	ND	9.9	ND	3.3	ND	3.3	ND	3.3
4,4'-DDD	8081A	(µg/Kg)	ND	3.3	ND	3.3	ND	3.3	ND	3.3	ND	3.3	ND	3.3	ND	3.3	ND	3.3	ND	3.3	ND	3.3	ND	3.3	ND	9.9	4.9	3.3	ND	3.3	ND	3.3
Endrin aldehyde	8081A	(µg/Kg)	ND	3.3	ND	3.3	ND	3.3	ND	3.3	ND	3.3	ND	3.3	ND	3.3	ND	3.3	ND	3.3	ND	3.3	ND	3.3	ND	9.9	ND	3.3	ND	3.3	ND	3.3
4,4'-DDT	8081A	(µg/Kg)	ND	3.3	ND	3.3	ND	3.3	ND	3.3	ND	3.3	ND	3.3	ND	3.3	ND	3.3	ND	3.3	ND #	3.3	ND #	3.3	ND #	9.9	ND #	3.3	ND #	3.3	ND #	3.3
alpha-Chlordane	8081A	(µg/Kg)	ND	1.7	ND	1.7	ND	1.7	ND	1.7	ND	1.7	ND	1.7	ND	1.7	ND	1.7	ND	1.7	ND	1.7	ND	1.7	ND	5.1	ND	1.7	ND	1.7	ND	1.7
gamma-Chlordane	8081A	(µg/Kg)	ND	1.7	ND	1.7	ND	1.7	ND	1.7	ND	1.7	ND	1.7	ND	1.7	ND	1.7	ND	1.7	ND	1.7	ND	1.7	ND	5.1	ND	1.7	ND	1.7	ND	1.7
Methoxychlor	8081A	(µg/Kg)	ND	17	ND	17	ND	17	ND	17	ND	17	ND	17	ND	17	ND	17	ND	17	ND	17	ND	17	ND	51	ND	17	ND	17	ND	17
Toxaphene	8081A	(µg/Kg)	ND	61	ND	59	ND	61	ND	59	ND	61	ND	59	ND	60	ND	61	ND	60	ND	60	ND	60	ND	180	ND	60	ND	59	ND	59
California Title 22 Metals TTLC[4]																																
Antimony	6010B	(mg/Kg)	ND	0.54	ND	0.47	ND	0.49	ND	0.53	ND	0.47	ND	0.56	ND	0.54	ND	0.53	ND	0.45	ND	0.49	1.1	0.52	ND	0.46	ND	0.50	ND	0.47	ND	0.51
Arsenic	6010B	(mg/Kg)	3.3	0.27	3.0	0.24	2.8	0.24	2.8	0.27	2.6	0.24	1.7	0.28	3.4	0.27	2.9	0.26	3.9	0.23	2.1	0.25	5.9	0.26	5.0	0.23	3.3	0.25	2.7	0.24	3.8	0.26
Barium	6010B	(mg/Kg)	200	0.27	200	0.24	45	0.24	98	0.27	110	0.24	140	0.28	140	0.27	150	0.26	120	0.23	40	0.25	140	0.26	150	0.23	160	0.25	33	0.24	130	0.26
Beryllium	6010B	(mg/Kg)	0.44	0.11	0.59	0.094	0.19	0.097	0.31	0.11	0.34	0.094	0.36	0.11	0.44	0.11	0.44	0.11	0.35	0.091	0.15	0.098	0.42	0.10	0.38	0.093	0.40	0.10	0.14	0.094	0.39	0.10
Cadmium	6010B	(mg/Kg)	ND	0.27	0.24	0.24	ND	0.24	ND	0.27	ND	0.24	ND	0.28	ND	0.27	ND	0.26	ND	0.23	ND	0.25	ND	0.26	ND	0.23	ND	0.25	ND	0.24	ND	0.26
Chromium	6010B	(mg/Kg)	91	0.27	88	0.24	23	0.24	62	0.27	78	0.24	110	0.28	120	0.27	96	0.26	67	0.23	25	0.25	54	0.26	60	0.23	110	0.25	8.5	0.24	78	0.26
Cobalt	6010B	(mg/Kg)	17	0.27	19	0.24	3.6	0.24	11	0.27	11	0.24	17	0.28	20	0.27	17	0.26	11	0.23	3.4	0.25	12	0.26	12	0.23	15	0.25	1.5	0.24	14	0.26
Copper	6010B	(mg/Kg)	34	0.27	40	0.24	10	0.24	24	0.27	30	0.24	31	0.28	38	0.27	33	0.26	25	0.23	7.8	0.25	27	0.26	29	0.23	31	0.25	4.7	0.24	43	0.26
Lead	6010B	(mg/Kg)	4.9	0.27	5.4	0.24	0.65	0.24	4.0	0.27	2.5	0.24	2.7	0.28	3.5	0.27	2.9	0.26	4.5	0.23	0.74	0.25	5.7	0.26	10	0.23	4.9	0.25	0.50	0.24	6.0	0.26
Mercury	7471A	(mg/Kg)	0.049	0.018	0.064	0.018	ND	0.018	0.035	0.018	0.054	0.018	0.068	0.017	0.063	0.018	0.056	0.018	0.042	0.018	0.061	0.018	0.045	0.017	0.071	0.017	0.054	0.018	ND	0.018	0.058	0.018
Molybdenum	6010B	(mg/Kg)	0.50	0.27	0.43	0.24	0.29	0.24	0.42	0.27	ND	0.24	ND	0.28	ND	0.27	ND	0.26	0.36	0.23	ND	0.25	ND	0.26	ND	0.23	ND	0.25	ND	0.24	ND	0.26
Nickel	6010B	(mg/Kg)	120	0.27	120	0.24	23	0.24	69	0.27	70	0.24	120	0.28	140	0.27	99	0.26	76	0.23	21	0.25	78	0.26	75	0.23	110	0.25	6.1	0.24	93	0.26
Selenium	6010B	(mg/Kg)	ND	0.54	ND	0.47	ND	0.49	ND	0.53	ND	0.47	ND	0.56	ND	0.54	ND	0.53	ND	0.45	ND	0.49	ND	0.52	ND	0.46	ND	0.50	ND	0.47	ND	0.51
Silver	6010B	(mg/Kg)	0.59	0.27	0.61	0.24	ND	0.24	0.48	0.27	0.61	0.24	0.74	0.28	0.73	0.27	0.60	0.26	0.45	0.23	ND	0.25	0.39	0.26	0.47	0.23	0.66	0.25	ND	0.24	0.55	0.26
Thallium	6010B	(mg/Kg)	ND	0.54	ND	0.47	ND	0.49	ND	0.53	ND	0.47	ND	0.56	ND	0.54	ND	0.53	ND	0.45	ND	0.49	ND	0.52	ND	0.46	ND	0.50	ND	0.47	ND	0.51
Vanadium	6010B	(mg/Kg)	62	0.27	69	0.24	20	0.24	55	0.27	78	0.24	83	0.28	90	0.27	80	0.26	46	0.23	19	0.25	43	0.26	56	0.23	83	0.25	9.6	0.24	70	0.26
Zinc	6010B	(mg/Kg)	49	1.1	60	0.94	23	0.97	43	1.1	49	0.94	47	1.1	54	1.1	48	1.1	43	0.91	21	0.98	53	1.0	53	0.93	53	1.0	26	0.94	48	1.0
California Title 22 Metals Chromium STLC[5]																																
Chromium	6010B	(µg/L)	710	250	910	250	-	-	260	250	260	250	480	250	400	250	420	250	370	250	-	-	ND	250	620	250	510	250	-	-	300	250

[1] Detect hydrocarbons

[2] Detect diesel and motor oil

[3] Detect pesticides

[4] Detect Title 22 Metals - Total threshold limit concentration

[5] Detect Title 22 Metals - Soluble threshold limit concentration

Y = Sample exhibits chromatographic pattern which does not resemble standard

RL = Reporting Limit

ND = Not Detected

= CCV drift outside limits; average CCV drift within limits per method requirement

C = Presence confirmed, but RPD between columns exceeds 40%

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Analytical Laboratories, Since 1878

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2323 Fifth Street, Berkeley, CA 94710, Phone (510) 486-0900

Laboratory Job Number 234035
ANALYTICAL REPORT

GEI Consultants, Inc.
180 Grand Avenue
Oakland, CA 94612

Project : 115400
Location : Lower Llagas Creek
Level : II

Sample ID	Lab ID
B-50+00W (1+2)	234035-001
B-59+00W (1+2)	234035-002
B-65+00E (1,2,3)	234035-003
B-127+00W (1,2)	234035-004
B-141+00W (1,2)	234035-005
B-166+50E (1,2)	234035-006
B-132+00W (1,2)	234035-007
B-173+50W (1,2)	234035-008
B-107+00W (1,2,3)	234035-009
B-92+50E (1,2,3)	234035-010
B-116+50E (1,2,3)	234035-011
B-92+50W (1,2)	234035-012
B-78+00W (1,2)	234035-013
B-132+50E (1,2)	234035-014
B-148+00E (1,2)	234035-015

This data package has been reviewed for technical correctness and completeness. Release of this data has been authorized by the Laboratory Manager or the Manager's designee, as verified by the following signature. The results contained in this report meet all requirements of NELAC and pertain only to those samples which were submitted for analysis. This report may be reproduced only in its entirety.

Signature: Denise N. Tetrault
Project Manager

Date: 02/03/2012

NELAP # 01107CA

CASE NARRATIVE

Laboratory number:	**234035**
Client:	**GEI Consultants, Inc.**
Project:	**115400**
Location:	**Lower Llagas Creek**
Request Date:	**01/26/12**
Samples Received:	**01/26/12**

This data package contains sample and QC results for fifteen soil samples, requested for the above referenced project on 01/26/12. The samples were received cold and intact.

TPH-Purgeables and/or BTXE by GC (EPA 8015B and EPA 8021B):
No analytical problems were encountered.

TPH-Extractables by GC (EPA 8015B):
B-92+50W (1,2) (lab # 234035-012) and B-78+00W (1,2) (lab # 234035-013) were diluted due to the dark and viscous nature of the sample extracts. No other analytical problems were encountered.

Pesticides (EPA 8081A):
All samples underwent sulfur cleanup using the copper option in EPA Method 3660B. All samples underwent florisil cleanup using EPA Method 3620C. Low surrogate recoveries were observed for TCMX in B-127+00W (1,2) (lab # 234035-004) and B-141+00W (1,2) (lab # 234035-005); the corresponding decachlorobiphenyl surrogate recoveries were within limits. B-92+50W (1,2) (lab # 234035-012) was diluted due to the color of the sample extract. No other analytical problems were encountered.

Metals (EPA 6010B and EPA 7471A):
No analytical problems were encountered.

CHAIN OF CUSTODY

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Berkeley, CA 94710

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C&T LOGIN # 234035

Page 1 of 2

Chain of Custody # ______

Project No: ~~LOWER LLAGAS CREEK~~ 115400

Project Name: LOWER LLAGAS CREEK

Project P. O. No:

EDD Format: Report Level ☐ II ☐ III ☐ IV

Turnaround Time: ☐ RUSH ______ ☒ Standard

Sampler: MATT POWERS

Report To: MATT POWERS

Company: GEI CONSULTANTS

Telephone: 510-350-2902

Email: mpowers@geiconsultants.com

Lab No.	Sample ID.	SAMPLING		MATRIX				# of Containers	CHEMICAL PRESERVATIVE					ANALYTICAL REQUEST			
		Date Collected	Time Collected	Water	Solid				HCl	H2SO4	HNO3	NaOH	None	TPHG + MTBE + BTEX	Diesel + motor oil	Pesticides	CAM 17
1	B-50+00W (1+2)	1/26/12	10:30A		X								X	/	/	/	/
2	B-59+00W (1+2)		10:32A		X								X	/	/	/	/
3	B-65+00E (1,2,3)		10:35A		X								X	/	/	/	/
4	B-127+00W (1,2)		11:05A		X								X	/	/	/	/
5	B-141+00W (1,2)		11:26		X								X	/	/	/	/
6	B-166+50E (1,2)		11:30A		X								X	/	/	/	/
7	B-132+00W (1,2)		11:40A		X								X	/	/	/	/
8	B-173+50W (1,2)		11:44A		X								X	/	/	/	/
9	B-107+00W (1,2,3)		12:00P		X								X	/	/	/	/
10	B-92+50E (1,2,3)		12:02P		X								X	/	/	/	/
11	B-116+50E (1,2,3		12:06P		X								X	/	/	/	/
12	B-92+50W (1,2)		12:33P		X								X	/	/	/	/
13	B-78+00W (1,2)		12:35P		X								X	/	/	/	/

Notes:

SAMPLE RECEIPT
☐ Intact
☐ Cold
☒ On Ice
☐ Ambient

RELINQUISHED BY:
DATE: ~~235~~ 1/26/12 TIME: 235
DATE: TIME:
DATE: TIME:

RECEIVED BY:
DATE: 1/26/12 TIME: 235
DATE: TIME:
DATE: TIME:

CHAIN OF CUSTODY

Curtis & Tompkins Laboratories
ENVIRONMENTAL ANALYTICAL TESTING LABORATORY
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C&T LOGIN # 234035

Page 2 of 2
Chain of Custody # ____

Project No: 115400
Project Name: LOWER LLAGAS CREEK
Project P. O. No:
EDD Format: Report Level ☐ II ☐ III ☐ IV
Turnaround Time: ☐ RUSH ____ ☒ Standard

Sampler: MATT POWERS
Report To: MATT POWERS
Company: GEI CONSULTANTS
Telephone: 510-350-2902
Email: mpowers@geiconsultants.com

Lab No.	Sample ID.	SAMPLING Date Collected	SAMPLING Time Collected	MATRIX Water	MATRIX Solid			# of Containers	CHEMICAL PRESERVATIVE HCl	H2SO4	HNO3	NaOH	None	ANALYTICAL REQUEST TPHG+MTBE+BTEX	Diesel+Motor Oil	Pesticides	CAM 17
14	B-132+50E (1,2)	1/26/12	12:44P		X								X	/	/	/	/
15	B-148+00E (1,2)	1/26/12	12:48P		X								X	/	/	/	/

Notes:

SAMPLE RECEIPT
☐ Intact
☐ Cold
☑ On Ice
☐ Ambient

RELINQUISHED BY:
DATE: 1/26/12 TIME: 235
DATE: TIME:
DATE: TIME:

RECEIVED BY:
Pat
DATE: 1/26/12 TIME: 2:35
DATE: TIME:
DATE: TIME:

COOLER RECEIPT CHECKLIST

Curtis & Tompkins, Ltd.

Login # 234035 Date Received 1/26/12 Number of coolers 1
Client GEI Consultants Project 115400 Lower Llagas Creek

Date Opened 1/26/12 By (print) I.CHOY (sign)
Date Logged in ↓ By (print) ↓ (sign) ↓

1. Did cooler come with a shipping slip (airbill, etc) YES [✓ NO]
Shipping info

2A. Were custody seals present? .... ☐ YES (circle) on cooler on samples ☒ NO
How many Name Date

2B. Were custody seals intact upon arrival? YES NO [✓ N/A]

3. Were custody papers dry and intact when received? [✓ YES] NO

4. Were custody papers filled out properly (ink, signed, etc)? [✓ YES] NO

5. Is the project identifiable from custody papers? (If so fill out top of form) [✓ YES] NO

6. Indicate the packing in cooler: (if other, describe)

☐ Bubble Wrap ☐ Foam blocks ☐ Bags ☒ None
☐ Cloth material ☐ Cardboard ☐ Styrofoam ☐ Paper towels

7. Temperature documentation: * Notify PM if temperature exceeds 6°C

Type of ice used: ☒ Wet ☐ Blue/Gel ☐ None Temp(°C) 2 4°C

☐ Samples Received on ice & cold without a temperature blank; temp. taken with IR gun

☒ Samples received on ice directly from the field. Cooling process had begun

8. Were Method 5035 sampling containers present? YES [✓ NO]
If YES, what time were they transferred to freezer?

9. Did all bottles arrive unbroken/unopened? [✓ YES] NO

10. Are there any missing / extra samples? YES [✓ NO]

11. Are samples in the appropriate containers for indicated tests? [✓ YES] NO

12. Are sample labels present, in good condition and complete? [✓ YES] NO

13. Do the sample labels agree with custody papers? YES [✓ NO]

14. Was sufficient amount of sample sent for tests requested? [✓ YES] NO

15. Are the samples appropriately preserved? YES NO [✓ N/A]

16. Did you check preservatives for all bottles for each sample? YES NO [✓ N/A]

17. Did you document your preservative check? YES NO [✓ N/A]

18. Did you change the hold time in LIMS for unpreserved VOAs? YES NO [✓ N/A]

19. Did you change the hold time in LIMS for preserved terracores? YES NO [✓ N/A]

20. Are bubbles > 6mm absent in VOA samples? YES NO [✓ N/A]

21. Was the client contacted concerning this sample delivery? YES [✓ NO]
If YES, Who was called? By Date:

COMMENTS

13) -012: sample label time does not agree w/ COC
↳ sample label time reads "12:35"
-013: sample label time does not agree w/ COC
↳ sample label time reads "12:33"

Rev 10, 11/11

Curtis & Tompkins Laboratories Analytical Report

Lab #:	234035	Location:	Lower Llagas Creek
Client:	GEI Consultants, Inc.	Prep:	EPA 5030B
Project#:	115400		
Matrix:	Soil	Batch#:	183276
Basis:	as received	Sampled:	01/26/12
Diln Fac:	1.000	Received:	01/26/12

Field ID:	B-50+00W (1+2)	Lab ID:	234035-001
Type:	SAMPLE	Analyzed:	01/26/12

Analyte	Result	RL	Units	Analysis
Gasoline C7-C12	ND	1.1	mg/Kg	EPA 8015B
MTBE	ND	22	ug/Kg	EPA 8021B
Benzene	ND	5.4	ug/Kg	EPA 8021B
Toluene	ND	5.4	ug/Kg	EPA 8021B
Ethylbenzene	ND	5.4	ug/Kg	EPA 8021B
m,p-Xylenes	ND	5.4	ug/Kg	EPA 8021B
o-Xylene	ND	5.4	ug/Kg	EPA 8021B

Surrogate	%REC	Limits	Analysis
Bromofluorobenzene (FID)	92	61-136	EPA 8015B
Bromofluorobenzene (PID)	99	63-128	EPA 8021B

Field ID:	B-59+00W (1+2)	Lab ID:	234035-002
Type:	SAMPLE	Analyzed:	01/26/12

Analyte	Result	RL	Units	Analysis
Gasoline C7-C12	ND	0.95	mg/Kg	EPA 8015B
MTBE	ND	19	ug/Kg	EPA 8021B
Benzene	ND	4.8	ug/Kg	EPA 8021B
Toluene	ND	4.8	ug/Kg	EPA 8021B
Ethylbenzene	ND	4.8	ug/Kg	EPA 8021B
m,p-Xylenes	ND	4.8	ug/Kg	EPA 8021B
o-Xylene	ND	4.8	ug/Kg	EPA 8021B

Surrogate	%REC	Limits	Analysis
Bromofluorobenzene (FID)	93	61-136	EPA 8015B
Bromofluorobenzene (PID)	101	63-128	EPA 8021B

Field ID:	B-65+00E (1,2,3)	Lab ID:	234035-003
Type:	SAMPLE	Analyzed:	01/27/12

Analyte	Result	RL	Units	Analysis
Gasoline C7-C12	ND	1.0	mg/Kg	EPA 8015B
MTBE	ND	20	ug/Kg	EPA 8021B
Benzene	ND	5.0	ug/Kg	EPA 8021B
Toluene	ND	5.0	ug/Kg	EPA 8021B
Ethylbenzene	ND	5.0	ug/Kg	EPA 8021B
m,p-Xylenes	ND	5.0	ug/Kg	EPA 8021B
o-Xylene	ND	5.0	ug/Kg	EPA 8021B

Surrogate	%REC	Limits	Analysis
Bromofluorobenzene (FID)	98	61-136	EPA 8015B
Bromofluorobenzene (PID)	106	63-128	EPA 8021B

ND= Not Detected
RL= Reporting Limit

Curtis & Tompkins Laboratories Analytical Report

Lab #:	234035	Location:	Lower Llagas Creek
Client:	GEI Consultants, Inc.	Prep:	EPA 5030B
Project#:	115400		
Matrix:	Soil	Batch#:	183276
Basis:	as received	Sampled:	01/26/12
Diln Fac:	1.000	Received:	01/26/12

Field ID:	B-127+00W (1,2)	Lab ID:	234035-004
Type:	SAMPLE	Analyzed:	01/27/12

Analyte	Result	RL	Units	Analysis
Gasoline C7-C12	ND	0.98	mg/Kg	EPA 8015B
MTBE	ND	20	ug/Kg	EPA 8021B
Benzene	ND	4.9	ug/Kg	EPA 8021B
Toluene	ND	4.9	ug/Kg	EPA 8021B
Ethylbenzene	ND	4.9	ug/Kg	EPA 8021B
m,p-Xylenes	ND	4.9	ug/Kg	EPA 8021B
o-Xylene	ND	4.9	ug/Kg	EPA 8021B

Surrogate	%REC	Limits	Analysis
Bromofluorobenzene (FID)	95	61-136	EPA 8015B
Bromofluorobenzene (PID)	103	63-128	EPA 8021B

Field ID:	B-141+00W (1,2)	Lab ID:	234035-005
Type:	SAMPLE	Analyzed:	01/27/12

Analyte	Result	RL	Units	Analysis
Gasoline C7-C12	ND	1.0	mg/Kg	EPA 8015B
MTBE	ND	21	ug/Kg	EPA 8021B
Benzene	ND	5.2	ug/Kg	EPA 8021B
Toluene	ND	5.2	ug/Kg	EPA 8021B
Ethylbenzene	ND	5.2	ug/Kg	EPA 8021B
m,p-Xylenes	ND	5.2	ug/Kg	EPA 8021B
o-Xylene	ND	5.2	ug/Kg	EPA 8021B

Surrogate	%REC	Limits	Analysis
Bromofluorobenzene (FID)	92	61-136	EPA 8015B
Bromofluorobenzene (PID)	100	63-128	EPA 8021B

Field ID:	B-166+50E (1,2)	Lab ID:	234035-006
Type:	SAMPLE	Analyzed:	01/27/12

Analyte	Result	RL	Units	Analysis
Gasoline C7-C12	ND	1.1	mg/Kg	EPA 8015B
MTBE	ND	22	ug/Kg	EPA 8021B
Benzene	ND	5.4	ug/Kg	EPA 8021B
Toluene	ND	5.4	ug/Kg	EPA 8021B
Ethylbenzene	ND	5.4	ug/Kg	EPA 8021B
m,p-Xylenes	ND	5.4	ug/Kg	EPA 8021B
o-Xylene	ND	5.4	ug/Kg	EPA 8021B

Surrogate	%REC	Limits	Analysis
Bromofluorobenzene (FID)	93	61-136	EPA 8015B
Bromofluorobenzene (PID)	101	63-128	EPA 8021B

ND= Not Detected
RL= Reporting Limit

Curtis & Tompkins Laboratories Analytical Report

Lab #:	234035	Location:	Lower Llagas Creek
Client:	GEI Consultants, Inc.	Prep:	EPA 5030B
Project#:	115400		
Matrix:	Soil	Batch#:	183276
Basis:	as received	Sampled:	01/26/12
Diln Fac:	1.000	Received:	01/26/12

Field ID: B-132+00W (1,2)
Type: SAMPLE
Lab ID: 234035-007
Analyzed: 01/27/12

Analyte	Result	RL	Units	Analysis
Gasoline C7-C12	ND	1.1	mg/Kg	EPA 8015B
MTBE	ND	22	ug/Kg	EPA 8021B
Benzene	ND	5.4	ug/Kg	EPA 8021B
Toluene	ND	5.4	ug/Kg	EPA 8021B
Ethylbenzene	ND	5.4	ug/Kg	EPA 8021B
m,p-Xylenes	ND	5.4	ug/Kg	EPA 8021B
o-Xylene	ND	5.4	ug/Kg	EPA 8021B

Surrogate	%REC	Limits	Analysis
Bromofluorobenzene (FID)	93	61-136	EPA 8015B
Bromofluorobenzene (PID)	100	63-128	EPA 8021B

Field ID: B-173+50W (1,2)
Type: SAMPLE
Lab ID: 234035-008
Analyzed: 01/27/12

Analyte	Result	RL	Units	Analysis
Gasoline C7-C12	ND	0.91	mg/Kg	EPA 8015B
MTBE	ND	18	ug/Kg	EPA 8021B
Benzene	ND	4.5	ug/Kg	EPA 8021B
Toluene	ND	4.5	ug/Kg	EPA 8021B
Ethylbenzene	ND	4.5	ug/Kg	EPA 8021B
m,p-Xylenes	ND	4.5	ug/Kg	EPA 8021B
o-Xylene	ND	4.5	ug/Kg	EPA 8021B

Surrogate	%REC	Limits	Analysis
Bromofluorobenzene (FID)	91	61-136	EPA 8015B
Bromofluorobenzene (PID)	100	63-128	EPA 8021B

Field ID: B-107+00W (1,2,3)
Type: SAMPLE
Lab ID: 234035-009
Analyzed: 01/27/12

Analyte	Result	RL	Units	Analysis
Gasoline C7-C12	ND	1.1	mg/Kg	EPA 8015B
MTBE	ND	22	ug/Kg	EPA 8021B
Benzene	ND	5.5	ug/Kg	EPA 8021B
Toluene	ND	5.5	ug/Kg	EPA 8021B
Ethylbenzene	ND	5.5	ug/Kg	EPA 8021B
m,p-Xylenes	ND	5.5	ug/Kg	EPA 8021B
o-Xylene	ND	5.5	ug/Kg	EPA 8021B

Surrogate	%REC	Limits	Analysis
Bromofluorobenzene (FID)	89	61-136	EPA 8015B
Bromofluorobenzene (PID)	99	63-128	EPA 8021B

ND= Not Detected
RL= Reporting Limit

Curtis & Tompkins Laboratories Analytical Report

Lab #:	234035	Location:	Lower Llagas Creek
Client:	GEI Consultants, Inc.	Prep:	EPA 5030B
Project#:	115400		
Matrix:	Soil	Batch#:	183276
Basis:	as received	Sampled:	01/26/12
Diln Fac:	1.000	Received:	01/26/12

Field ID:	B-92+50E (1,2,3)	Lab ID:	234035-010
Type:	SAMPLE	Analyzed:	01/27/12

Analyte	Result	RL	Units	Analysis
Gasoline C7-C12	ND	0.99	mg/Kg	EPA 8015B
MTBE	ND	20	ug/Kg	EPA 8021B
Benzene	ND	5.0	ug/Kg	EPA 8021B
Toluene	ND	5.0	ug/Kg	EPA 8021B
Ethylbenzene	ND	5.0	ug/Kg	EPA 8021B
m,p-Xylenes	ND	5.0	ug/Kg	EPA 8021B
o-Xylene	ND	5.0	ug/Kg	EPA 8021B

Surrogate	%REC	Limits	Analysis
Bromofluorobenzene (FID)	94	61-136	EPA 8015B
Bromofluorobenzene (PID)	104	63-128	EPA 8021B

Field ID:	B-116+50E (1,2,3)	Lab ID:	234035-011
Type:	SAMPLE	Analyzed:	01/27/12

Analyte	Result	RL	Units	Analysis
Gasoline C7-C12	ND	1.1	mg/Kg	EPA 8015B
MTBE	ND	21	ug/Kg	EPA 8021B
Benzene	ND	5.3	ug/Kg	EPA 8021B
Toluene	ND	5.3	ug/Kg	EPA 8021B
Ethylbenzene	ND	5.3	ug/Kg	EPA 8021B
m,p-Xylenes	ND	5.3	ug/Kg	EPA 8021B
o-Xylene	ND	5.3	ug/Kg	EPA 8021B

Surrogate	%REC	Limits	Analysis
Bromofluorobenzene (FID)	85	61-136	EPA 8015B
Bromofluorobenzene (PID)	93	63-128	EPA 8021B

Field ID:	B-92+50W (1,2)	Lab ID:	234035-012
Type:	SAMPLE	Analyzed:	01/27/12

Analyte	Result	RL	Units	Analysis
Gasoline C7-C12	ND	0.94	mg/Kg	EPA 8015B
MTBE	ND	19	ug/Kg	EPA 8021B
Benzene	ND	4.7	ug/Kg	EPA 8021B
Toluene	ND	4.7	ug/Kg	EPA 8021B
Ethylbenzene	ND	4.7	ug/Kg	EPA 8021B
m,p-Xylenes	ND	4.7	ug/Kg	EPA 8021B
o-Xylene	ND	4.7	ug/Kg	EPA 8021B

Surrogate	%REC	Limits	Analysis
Bromofluorobenzene (FID)	88	61-136	EPA 8015B
Bromofluorobenzene (PID)	97	63-128	EPA 8021B

ND= Not Detected
RL= Reporting Limit

Curtis & Tompkins Laboratories Analytical Report

Lab #:	234035	Location:	Lower Llagas Creek
Client:	GEI Consultants, Inc.	Prep:	EPA 5030B
Project#:	115400		
Matrix:	Soil	Batch#:	183276
Basis:	as received	Sampled:	01/26/12
Diln Fac:	1.000	Received:	01/26/12

Field ID:	B-78+00W (1,2)	Lab ID:	234035-013
Type:	SAMPLE	Analyzed:	01/27/12

Analyte	Result	RL	Units	Analysis
Gasoline C7-C12	ND	0.96	mg/Kg	EPA 8015B
MTBE	ND	19	ug/Kg	EPA 8021B
Benzene	ND	4.8	ug/Kg	EPA 8021B
Toluene	ND	4.8	ug/Kg	EPA 8021B
Ethylbenzene	ND	4.8	ug/Kg	EPA 8021B
m,p-Xylenes	ND	4.8	ug/Kg	EPA 8021B
o-Xylene	ND	4.8	ug/Kg	EPA 8021B

Surrogate	%REC	Limits	Analysis
Bromofluorobenzene (FID)	90	61-136	EPA 8015B
Bromofluorobenzene (PID)	99	63-128	EPA 8021B

Field ID:	B-132+50E (1,2)	Lab ID:	234035-014
Type:	SAMPLE	Analyzed:	01/27/12

Analyte	Result	RL	Units	Analysis
Gasoline C7-C12	ND	0.99	mg/Kg	EPA 8015B
MTBE	ND	20	ug/Kg	EPA 8021B
Benzene	ND	5.0	ug/Kg	EPA 8021B
Toluene	ND	5.0	ug/Kg	EPA 8021B
Ethylbenzene	ND	5.0	ug/Kg	EPA 8021B
m,p-Xylenes	ND	5.0	ug/Kg	EPA 8021B
o-Xylene	ND	5.0	ug/Kg	EPA 8021B

Surrogate	%REC	Limits	Analysis
Bromofluorobenzene (FID)	90	61-136	EPA 8015B
Bromofluorobenzene (PID)	98	63-128	EPA 8021B

Field ID:	B-148+00E (1,2)	Lab ID:	234035-015
Type:	SAMPLE	Analyzed:	01/27/12

Analyte	Result	RL	Units	Analysis
Gasoline C7-C12	ND	0.94	mg/Kg	EPA 8015B
MTBE	ND	19	ug/Kg	EPA 8021B
Benzene	ND	4.7	ug/Kg	EPA 8021B
Toluene	ND	4.7	ug/Kg	EPA 8021B
Ethylbenzene	ND	4.7	ug/Kg	EPA 8021B
m,p-Xylenes	ND	4.7	ug/Kg	EPA 8021B
o-Xylene	ND	4.7	ug/Kg	EPA 8021B

Surrogate	%REC	Limits	Analysis
Bromofluorobenzene (FID)	90	61-136	EPA 8015B
Bromofluorobenzene (PID)	100	63-128	EPA 8021B

ND= Not Detected
RL= Reporting Limit

Curtis & Tompkins Laboratories Analytical Report

Lab #:	234035	Location:	Lower Llagas Creek
Client:	GEI Consultants, Inc.	Prep:	EPA 5030B
Project#:	115400		
Matrix:	Soil	Batch#:	183276
Basis:	as received	Sampled:	01/26/12
Diln Fac:	1.000	Received:	01/26/12

Type:	BLANK	Analyzed:	01/26/12
Lab ID:	QC626637		

Analyte	Result	RL	Units	Analysis
Gasoline C7-C12	ND	0.20	mg/Kg	EPA 8015B
MTBE	ND	4.0	ug/Kg	EPA 8021B
Benzene	ND	1.0	ug/Kg	EPA 8021B
Toluene	ND	1.0	ug/Kg	EPA 8021B
Ethylbenzene	ND	1.0	ug/Kg	EPA 8021B
m,p-Xylenes	ND	1.0	ug/Kg	EPA 8021B
o-Xylene	ND	1.0	ug/Kg	EPA 8021B

Surrogate	%REC	Limits	Analysis
Bromofluorobenzene (FID)	95	61-136	EPA 8015B
Bromofluorobenzene (PID)	103	63-128	EPA 8021B

ND= Not Detected
RL= Reporting Limit

Batch QC Report

Curtis & Tompkins Laboratories Analytical Report

Lab #:	234035	Location:	Lower Llagas Creek
Client:	GEI Consultants, Inc.	Prep:	EPA 5030B
Project#:	115400	Analysis:	EPA 8021B
Matrix:	Soil	Batch#:	183276
Units:	ug/Kg	Analyzed:	01/26/12
Diln Fac:	1.000		

Type: BS

Lab ID: QC626634

Analyte	Spiked	Result	%REC	Limits
MTBE	10.00	10.76	108	47-159
Benzene	10.00	10.37	104	80-120
Toluene	10.00	10.17	102	80-120
Ethylbenzene	10.00	10.17	102	80-120
m,p-Xylenes	10.00	10.31	103	80-120
o-Xylene	10.00	10.34	103	80-120

Surrogate	%REC	Limits
Bromofluorobenzene (PID)	101	63-128

Type: BSD

Lab ID: QC626635

Analyte	Spiked	Result	%REC	Limits	RPD	Lim
MTBE	10.00	11.35	113	47-159	5	73
Benzene	10.00	10.19	102	80-120	2	28
Toluene	10.00	10.13	101	80-120	0	20
Ethylbenzene	10.00	10.22	102	80-120	0	20
m,p-Xylenes	10.00	10.25	102	80-120	1	20
o-Xylene	10.00	10.33	103	80-120	0	20

Surrogate	%REC	Limits
Bromofluorobenzene (PID)	105	63-128

RPD= Relative Percent Difference

Batch QC Report

Curtis & Tompkins Laboratories Analytical Report

Lab #:	234035	Location:	Lower Llagas Creek
Client:	GEI Consultants, Inc.	Prep:	EPA 5030B
Project#:	115400	Analysis:	EPA 8015B
Type:	LCS	Diln Fac:	1.000
Lab ID:	QC626636	Batch#:	183276
Matrix:	Soil	Analyzed:	01/26/12
Units:	mg/Kg		

Analyte	Spiked	Result	%REC	Limits
Gasoline C7-C12	1.000	1.004	100	79-120

Surrogate	%REC	Limits
Bromofluorobenzene (FID)	97	61-136

Batch QC Report

Curtis & Tompkins Laboratories Analytical Report

Lab #:	234035	Location:	Lower Llagas Creek
Client:	GEI Consultants, Inc.	Prep:	EPA 5030B
Project#:	115400	Analysis:	EPA 8015B
Field ID:	ZZZZZZZZZZ	Diln Fac:	1.000
MSS Lab ID:	234022-001	Batch#:	183276
Matrix:	Soil	Sampled:	01/26/12
Units:	mg/Kg	Received:	01/26/12
Basis:	as received	Analyzed:	01/26/12

Type: MS

Lab ID: QC626638

Analyte	MSS Result	Spiked	Result	%REC	Limits
Gasoline C7-C12	0.1260	9.346	6.290	66	31-120

Surrogate	%REC	Limits
Bromofluorobenzene (FID)	92	61-136

Type: MSD

Lab ID: QC626639

Analyte	Spiked	Result	%REC	Limits	RPD	Lim
Gasoline C7-C12	10.87	7.364	67	31-120	1	57

Surrogate	%REC	Limits
Bromofluorobenzene (FID)	92	61-136

RPD= Relative Percent Difference

Total Extractable Hydrocarbons

Lab #:	234035	Location:	Lower Llagas Creek
Client:	GEI Consultants, Inc.	Prep:	SHAKER TABLE
Project#:	115400	Analysis:	EPA 8015B
Matrix:	Soil	Sampled:	01/26/12
Units:	mg/Kg	Received:	01/26/12
Basis:	as received	Prepared:	01/27/12
Batch#:	183299		

Field ID: B-50+00W (1+2)
Type: SAMPLE
Lab ID: 234035-001
Diln Fac: 1.000
Analyzed: 01/30/12

Analyte	Result	RL
Diesel C10-C24	12 Y	0.99
Motor Oil C24-C36	50	5.0

Surrogate	%REC	Limits
o-Terphenyl	106	49-128

Field ID: B-59+00W (1+2)
Type: SAMPLE
Lab ID: 234035-002
Diln Fac: 1.000
Analyzed: 01/30/12

Analyte	Result	RL
Diesel C10-C24	5.2 Y	1.0
Motor Oil C24-C36	35	5.0

Surrogate	%REC	Limits
o-Terphenyl	111	49-128

Field ID: B-65+00E (1,2,3)
Type: SAMPLE
Lab ID: 234035-003
Diln Fac: 1.000
Analyzed: 01/30/12

Analyte	Result	RL
Diesel C10-C24	130 Y	1.0
Motor Oil C24-C36	25	5.0

Surrogate	%REC	Limits
o-Terphenyl	99	49-128

Field ID: B-127+00W (1,2)
Type: SAMPLE
Lab ID: 234035-004
Diln Fac: 1.000
Analyzed: 01/30/12

Analyte	Result	RL
Diesel C10-C24	13 Y	1.0
Motor Oil C24-C36	47	5.0

Surrogate	%REC	Limits
o-Terphenyl	105	49-128

Y= Sample exhibits chromatographic pattern which does not resemble standard
DO= Diluted Out
ND= Not Detected
RL= Reporting Limit

Total Extractable Hydrocarbons

Lab #:	234035	Location:	Lower Llagas Creek
Client:	GEI Consultants, Inc.	Prep:	SHAKER TABLE
Project#:	115400	Analysis:	EPA 8015B
Matrix:	Soil	Sampled:	01/26/12
Units:	mg/Kg	Received:	01/26/12
Basis:	as received	Prepared:	01/27/12
Batch#:	183299		

Field ID:	B-141+00W (1,2)	Diln Fac:	1.000
Type:	SAMPLE	Analyzed:	01/29/12
Lab ID:	234035-005		

Analyte	Result	RL
Diesel C10-C24	ND	1.0
Motor Oil C24-C36	ND	5.0

Surrogate	%REC	Limits
o-Terphenyl	107	49-128

Field ID:	B-166+50E (1,2)	Diln Fac:	1.000
Type:	SAMPLE	Analyzed:	01/29/12
Lab ID:	234035-006		

Analyte	Result	RL
Diesel C10-C24	1.2 Y	0.99
Motor Oil C24-C36	5.1	5.0

Surrogate	%REC	Limits
o-Terphenyl	98	49-128

Field ID:	B-132+00W (1,2)	Diln Fac:	1.000
Type:	SAMPLE	Analyzed:	01/29/12
Lab ID:	234035-007		

Analyte	Result	RL
Diesel C10-C24	2.3 Y	1.0
Motor Oil C24-C36	15	5.0

Surrogate	%REC	Limits
o-Terphenyl	98	49-128

Field ID:	B-173+50W (1,2)	Diln Fac:	1.000
Type:	SAMPLE	Analyzed:	01/29/12
Lab ID:	234035-008		

Analyte	Result	RL
Diesel C10-C24	1.5 Y	1.0
Motor Oil C24-C36	6.0	5.0

Surrogate	%REC	Limits
o-Terphenyl	92	49-128

Y= Sample exhibits chromatographic pattern which does not resemble standard
DO= Diluted Out
ND= Not Detected
RL= Reporting Limit

Total Extractable Hydrocarbons

Lab #:	234035	Location:	Lower Llagas Creek
Client:	GEI Consultants, Inc.	Prep:	SHAKER TABLE
Project#:	115400	Analysis:	EPA 8015B
Matrix:	Soil	Sampled:	01/26/12
Units:	mg/Kg	Received:	01/26/12
Basis:	as received	Prepared:	01/27/12
Batch#:	183299		

Field ID:	B-107+00W (1,2,3)	Diln Fac:	1.000
Type:	SAMPLE	Analyzed:	01/30/12
Lab ID:	234035-009		

Analyte	Result	RL
Diesel C10-C24	5.7 Y	1.0
Motor Oil C24-C36	45	5.0

Surrogate	%REC	Limits
o-Terphenyl	89	49-128

Field ID:	B-92+50E (1,2,3)	Diln Fac:	1.000
Type:	SAMPLE	Analyzed:	01/30/12
Lab ID:	234035-010		

Analyte	Result	RL
Diesel C10-C24	12 Y	1.0
Motor Oil C24-C36	9.5	5.0

Surrogate	%REC	Limits
o-Terphenyl	89	49-128

Field ID:	B-116+50E (1,2,3)	Diln Fac:	1.000
Type:	SAMPLE	Analyzed:	01/29/12
Lab ID:	234035-011		

Analyte	Result	RL
Diesel C10-C24	2.9 Y	1.0
Motor Oil C24-C36	20	5.0

Surrogate	%REC	Limits
o-Terphenyl	94	49-128

Field ID:	B-92+50W (1,2)	Diln Fac:	10.00
Type:	SAMPLE	Analyzed:	01/30/12
Lab ID:	234035-012		

Analyte	Result	RL
Diesel C10-C24	24 Y	20
Motor Oil C24-C36	230	100

Surrogate	%REC	Limits
o-Terphenyl	DO	49-128

Y= Sample exhibits chromatographic pattern which does not resemble standard
DO= Diluted Out
ND= Not Detected
RL= Reporting Limit

Total Extractable Hydrocarbons

Lab #:	234035	Location:	Lower Llagas Creek
Client:	GEI Consultants, Inc.	Prep:	SHAKER TABLE
Project#:	115400	Analysis:	EPA 8015B
Matrix:	Soil	Sampled:	01/26/12
Units:	mg/Kg	Received:	01/26/12
Basis:	as received	Prepared:	01/27/12
Batch#:	183299		

Field ID:	B-78+00W (1,2)	Diln Fac:	5.000
Type:	SAMPLE	Analyzed:	01/29/12
Lab ID:	234035-013		

Analyte	Result	RL
Diesel C10-C24	13 Y	10
Motor Oil C24-C36	96	50

Surrogate	%REC	Limits
o-Terphenyl	DO	49-128

Field ID:	B-132+50E (1,2)	Diln Fac:	1.000
Type:	SAMPLE	Analyzed:	01/30/12
Lab ID:	234035-014		

Analyte	Result	RL
Diesel C10-C24	160 Y	1.0
Motor Oil C24-C36	8.0	5.0

Surrogate	%REC	Limits
o-Terphenyl	96	49-128

Field ID:	B-148+00E (1,2)	Diln Fac:	1.000
Type:	SAMPLE	Analyzed:	01/30/12
Lab ID:	234035-015		

Analyte	Result	RL
Diesel C10-C24	8.9 Y	1.0
Motor Oil C24-C36	45	5.0

Surrogate	%REC	Limits
o-Terphenyl	96	49-128

Type:	BLANK	Diln Fac:	1.000
Lab ID:	QC626741	Analyzed:	01/29/12

Analyte	Result	RL
Diesel C10-C24	ND	1.0
Motor Oil C24-C36	ND	5.0

Surrogate	%REC	Limits
o-Terphenyl	97	49-128

Y= Sample exhibits chromatographic pattern which does not resemble standard
DO= Diluted Out
ND= Not Detected
RL= Reporting Limit

Batch QC Report

Total Extractable Hydrocarbons

Lab #:	234035	Location:	Lower Llagas Creek
Client:	GEI Consultants, Inc.	Prep:	SHAKER TABLE
Project#:	115400	Analysis:	EPA 8015B
Type:	LCS	Diln Fac:	1.000
Lab ID:	QC626742	Batch#:	183299
Matrix:	Soil	Prepared:	01/27/12
Units:	mg/Kg	Analyzed:	01/29/12

Analyte	Spiked	Result	%REC	Limits
Diesel C10-C24	49.71	45.55	92	47-132

Surrogate	%REC	Limits
o-Terphenyl	92	49-128

Batch QC Report

Total Extractable Hydrocarbons

Lab #:	234035	Location:	Lower Llagas Creek
Client:	GEI Consultants, Inc.	Prep:	SHAKER TABLE
Project#:	115400	Analysis:	EPA 8015B
Field ID:	B-78+00W (1,2)	Batch#:	183299
MSS Lab ID:	234035-013	Sampled:	01/26/12
Matrix:	Soil	Received:	01/26/12
Units:	mg/Kg	Prepared:	01/27/12
Basis:	as received	Analyzed:	01/29/12
Diln Fac:	5.000		

Type: MS Lab ID: QC626743

Analyte	MSS Result	Spiked	Result	%REC	Limits
Diesel C10-C24	13.22	50.21	67.27	108	32-143

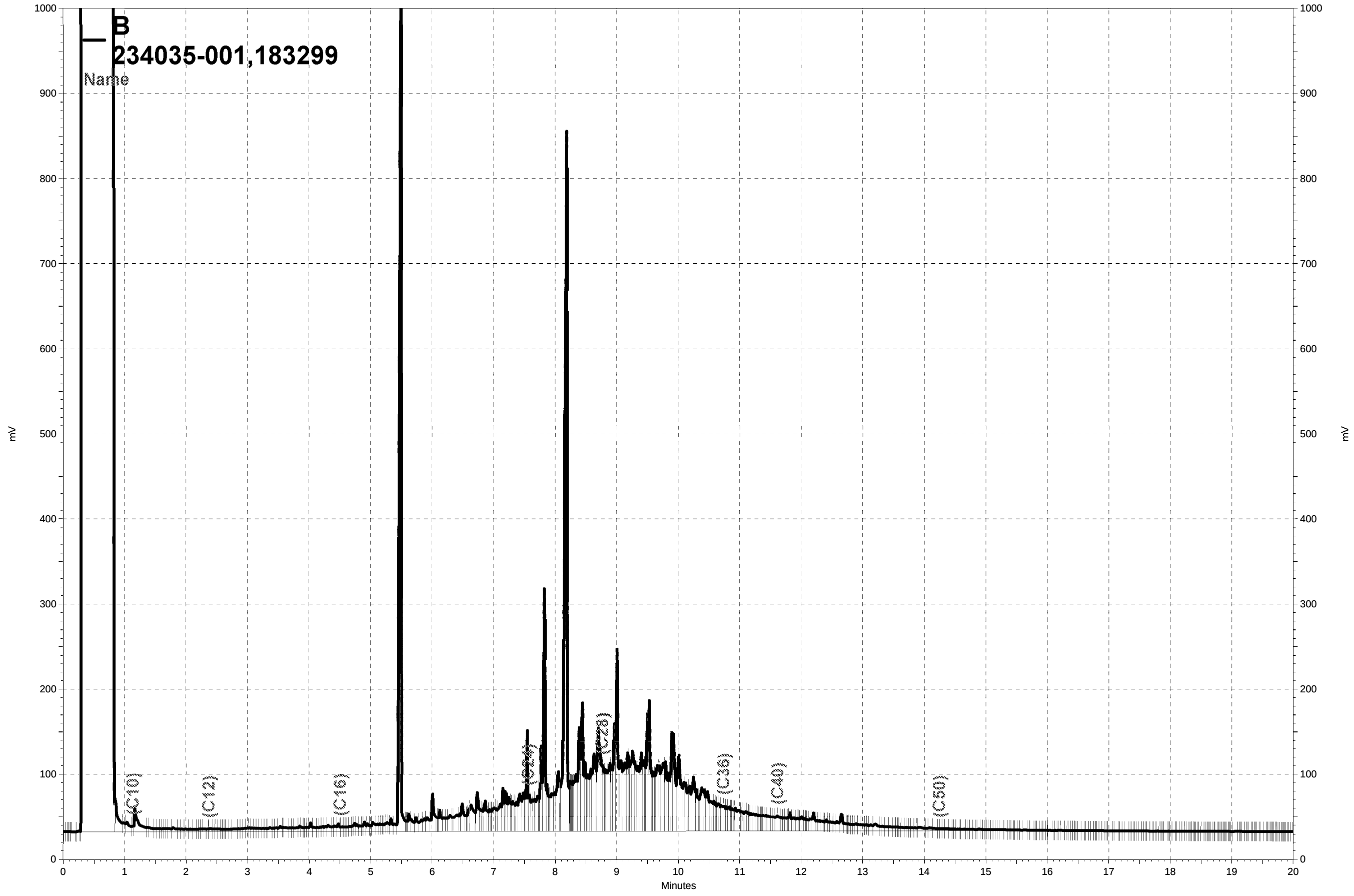
Surrogate	%REC	Limits
o-Terphenyl	DO	49-128

Type: MSD Lab ID: QC626744

Analyte	Spiked	Result	%REC	Limits	RPD	Lim
Diesel C10-C24	49.98	63.38	100	32-143	6	54

Surrogate	%REC	Limits
o-Terphenyl	DO	49-128

DO= Diluted Out
RPD= Relative Percent Difference



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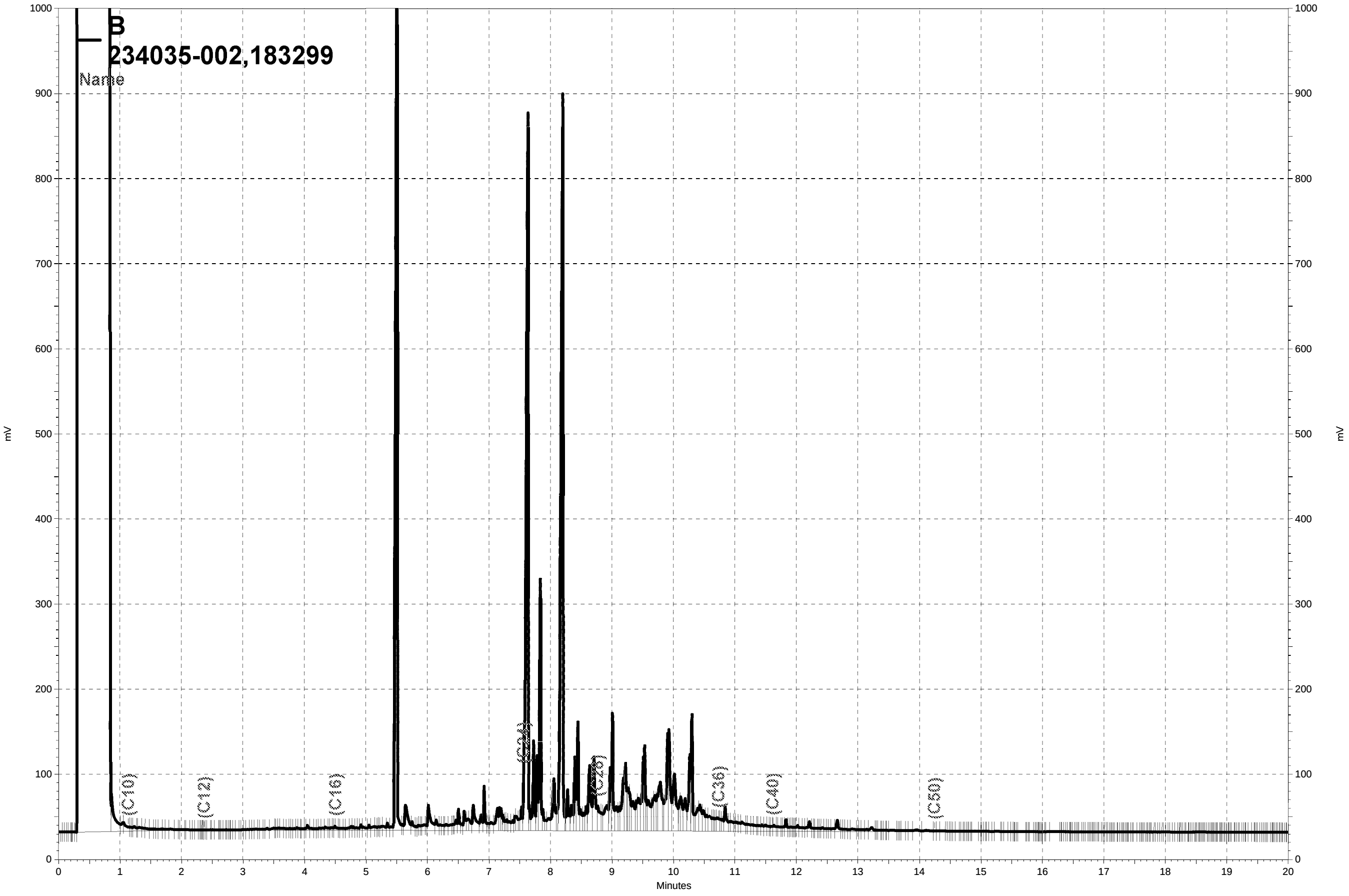

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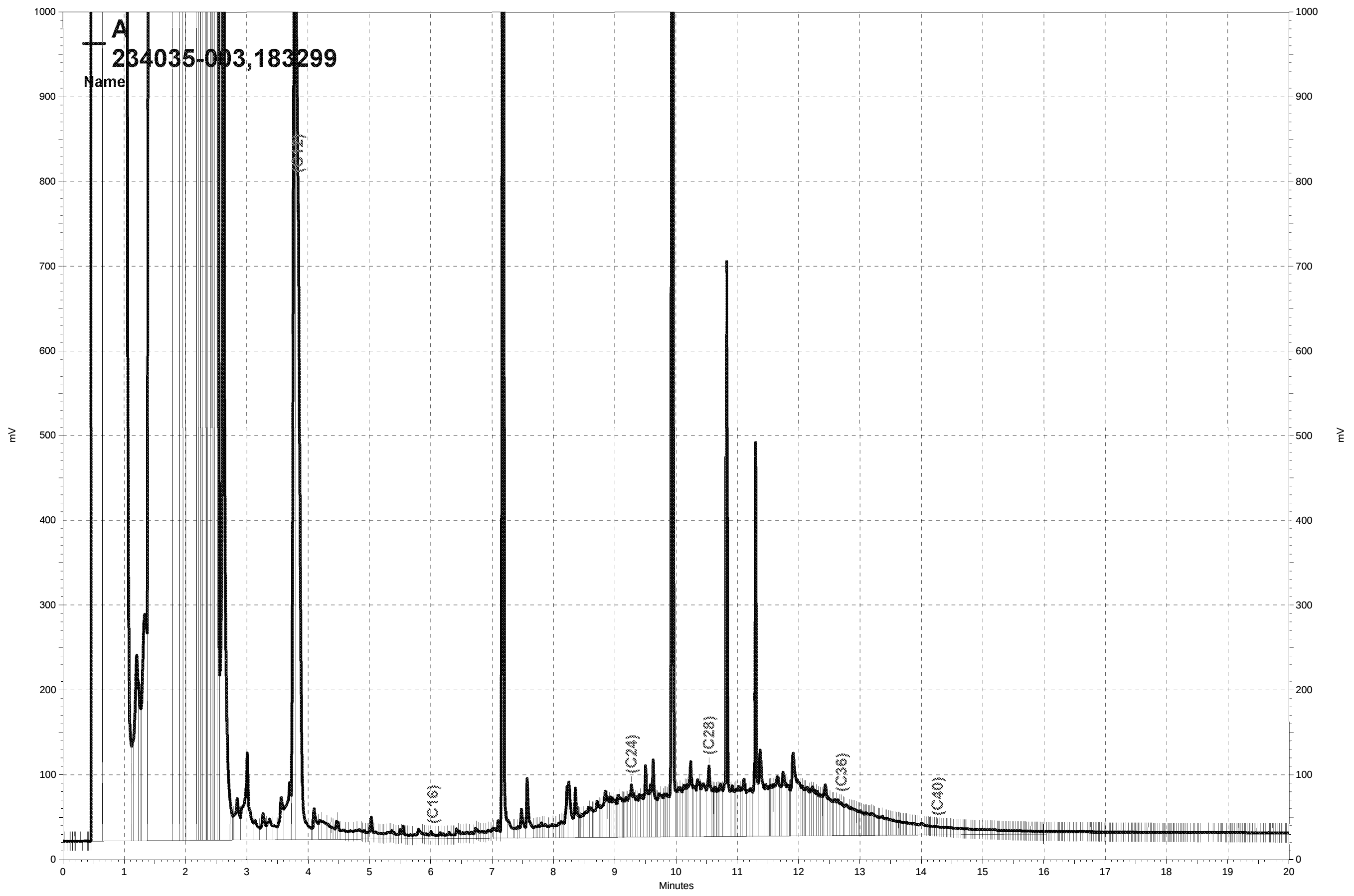

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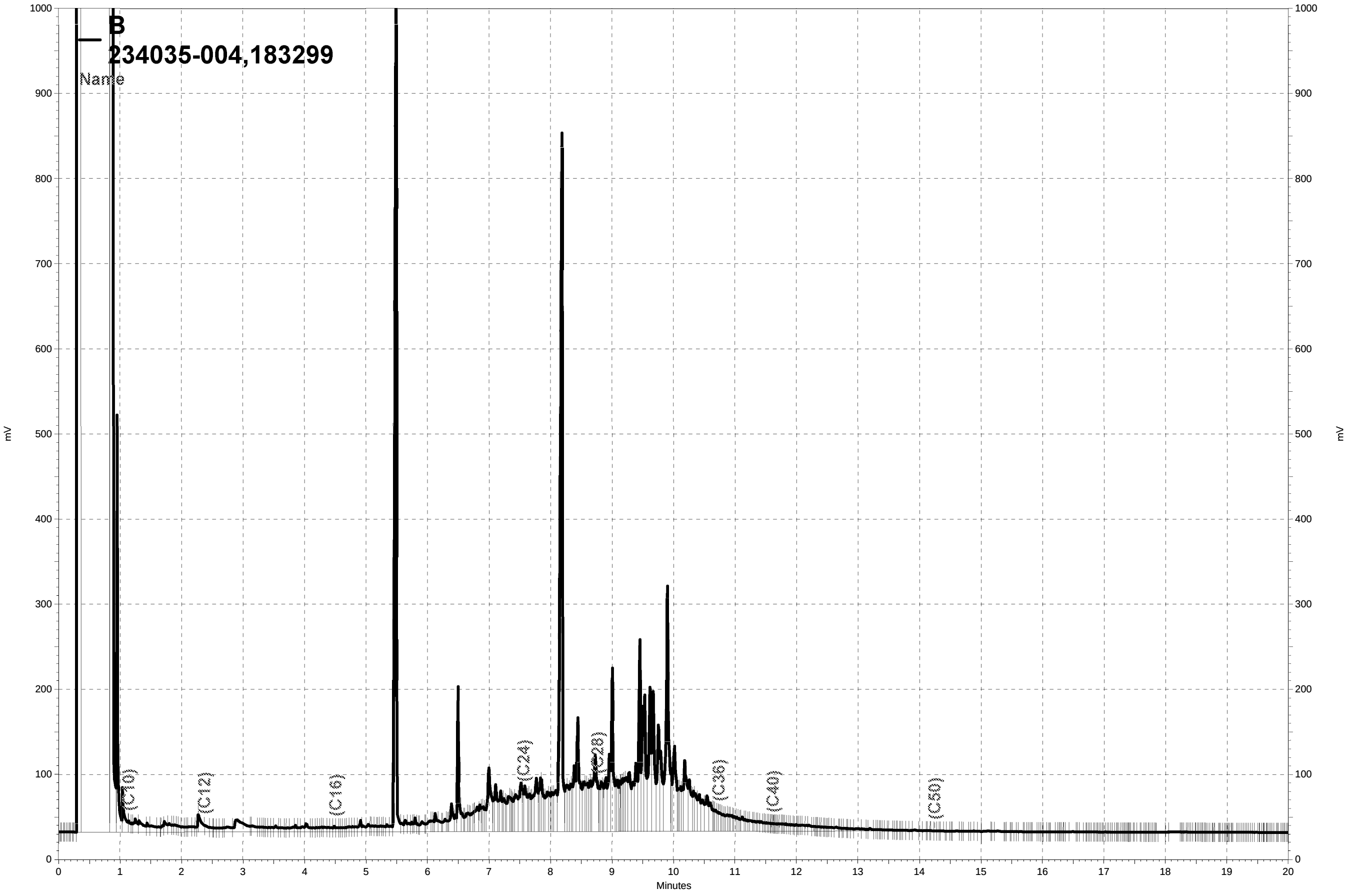

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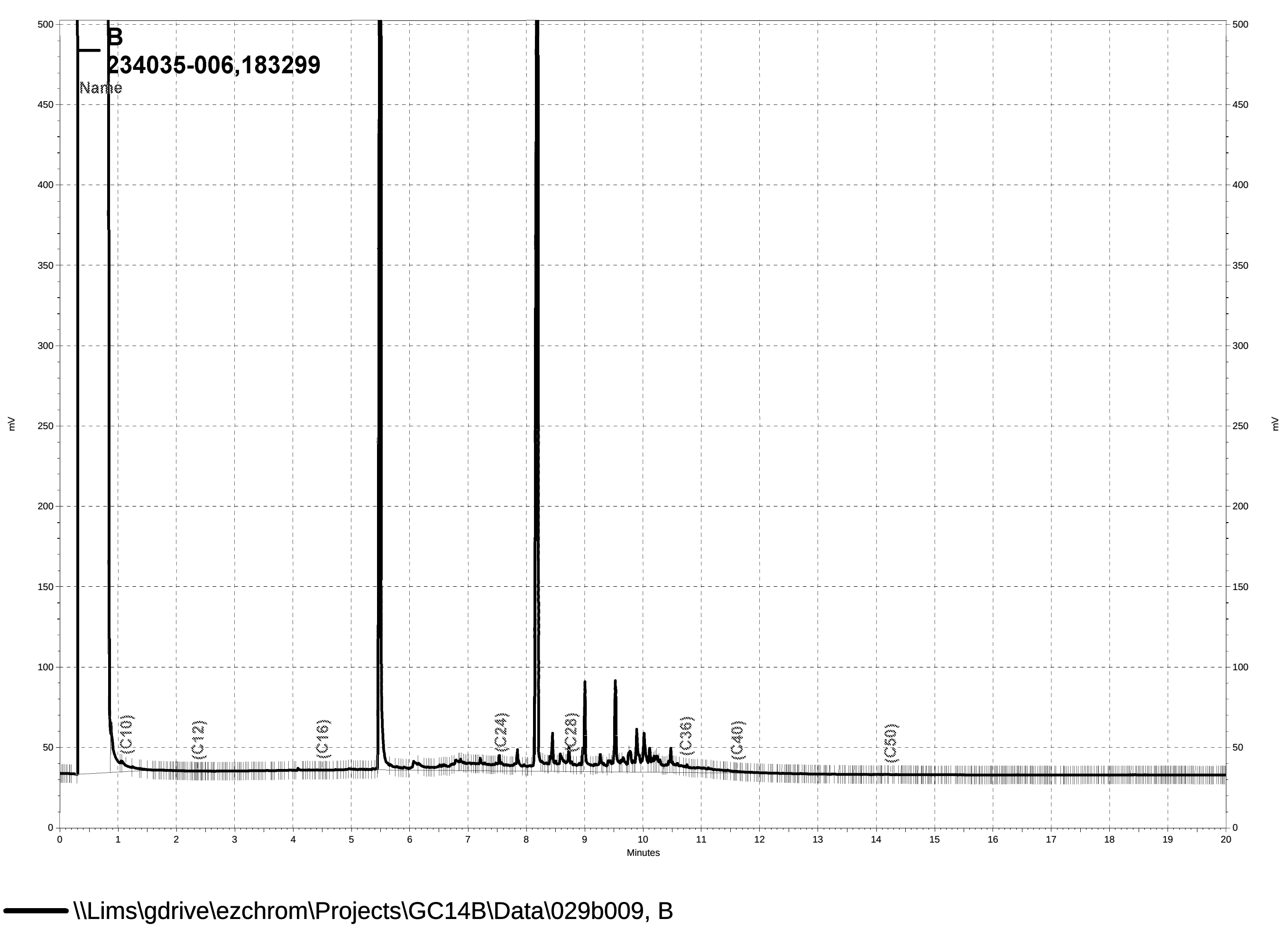
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(C12)
(C16)
(C24)
(C28)
(C36)
(C40)
(C50)
0
1
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19
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Minutes
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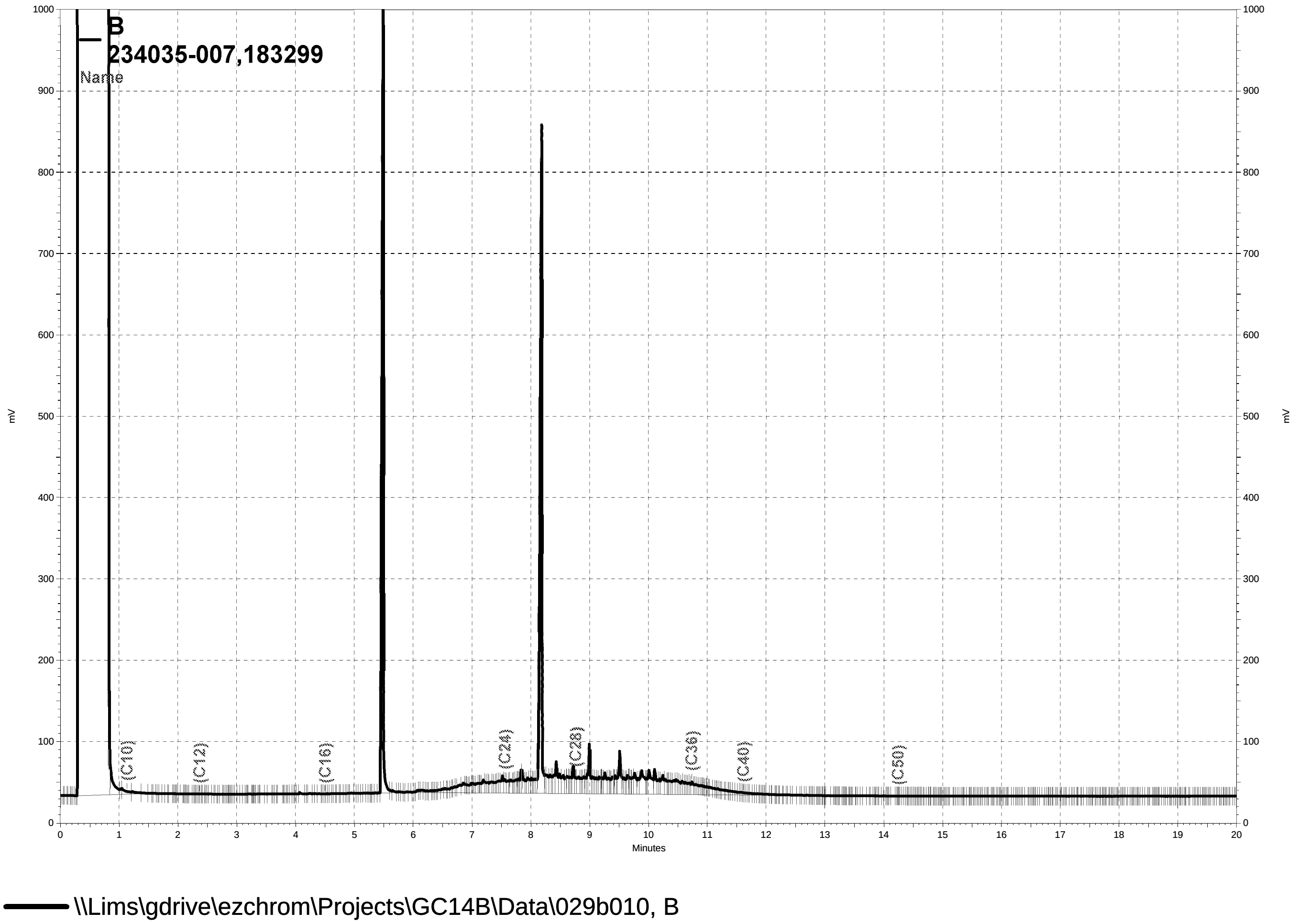
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(C12)
(C16)
(C24)
(C28)
(C36)
(C40)
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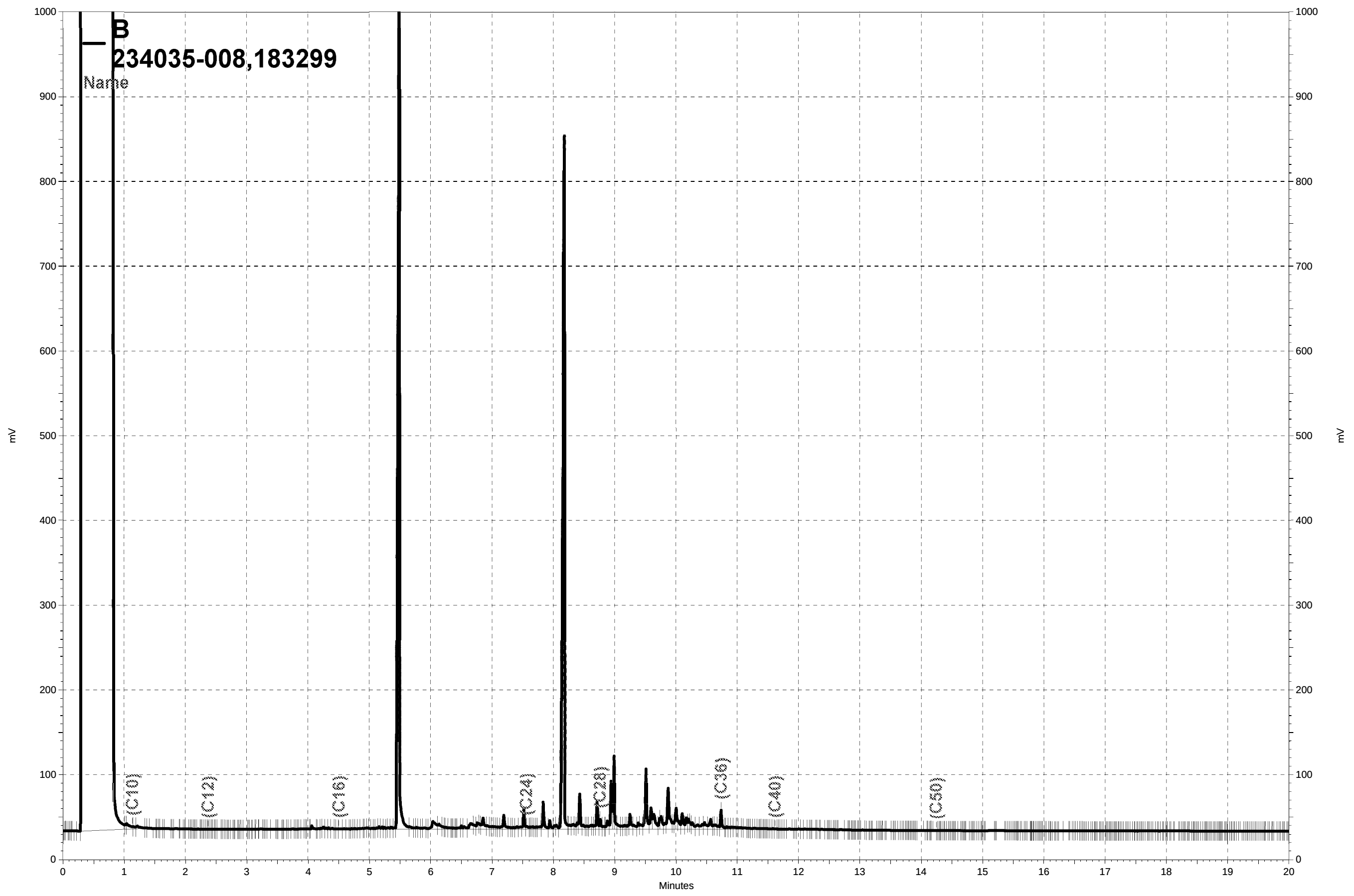

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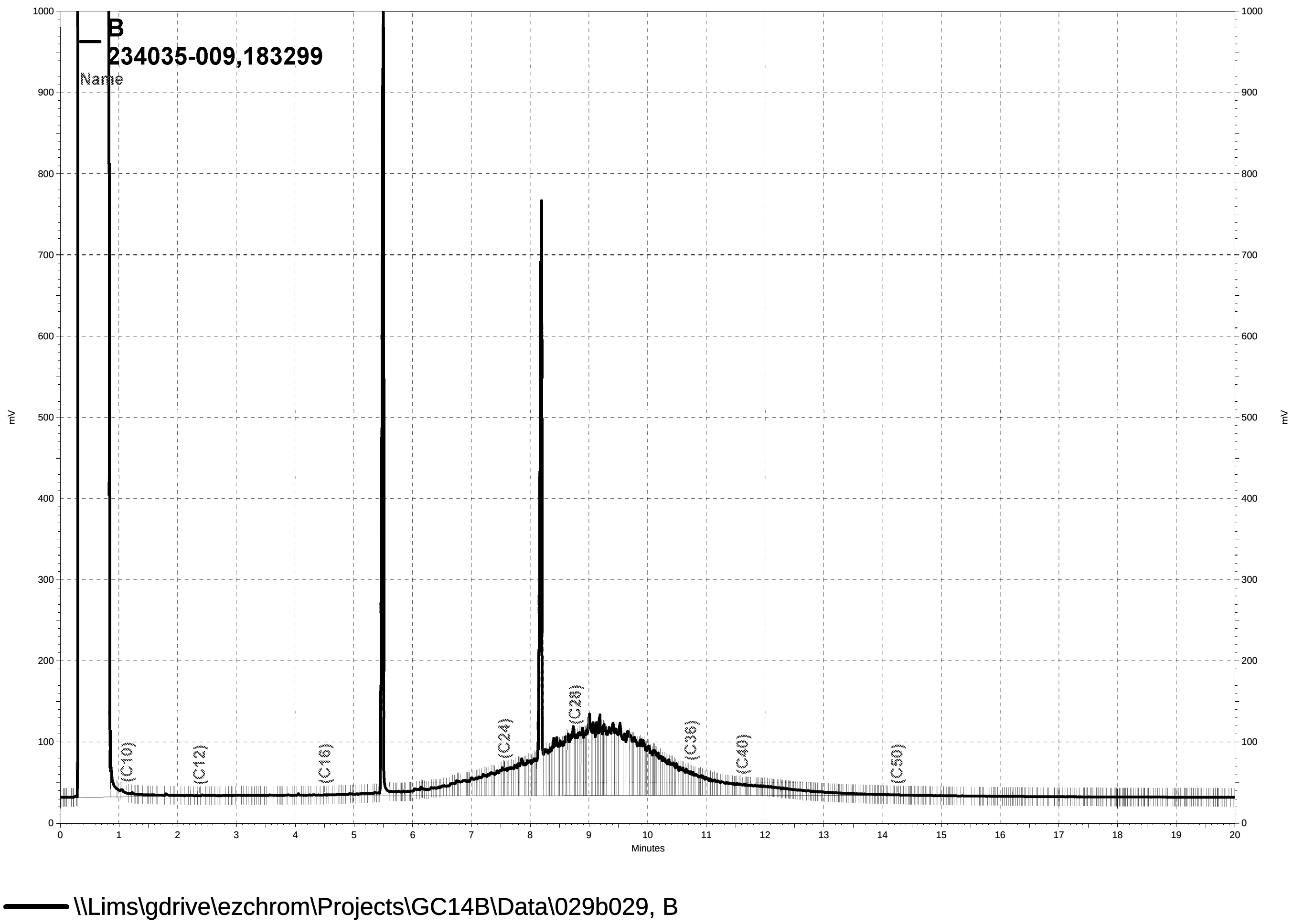
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600
700
800
900
1000
0
1
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4
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6
7
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15
16
17
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19
20
(C10)
(C12)
(C16)
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(C50)
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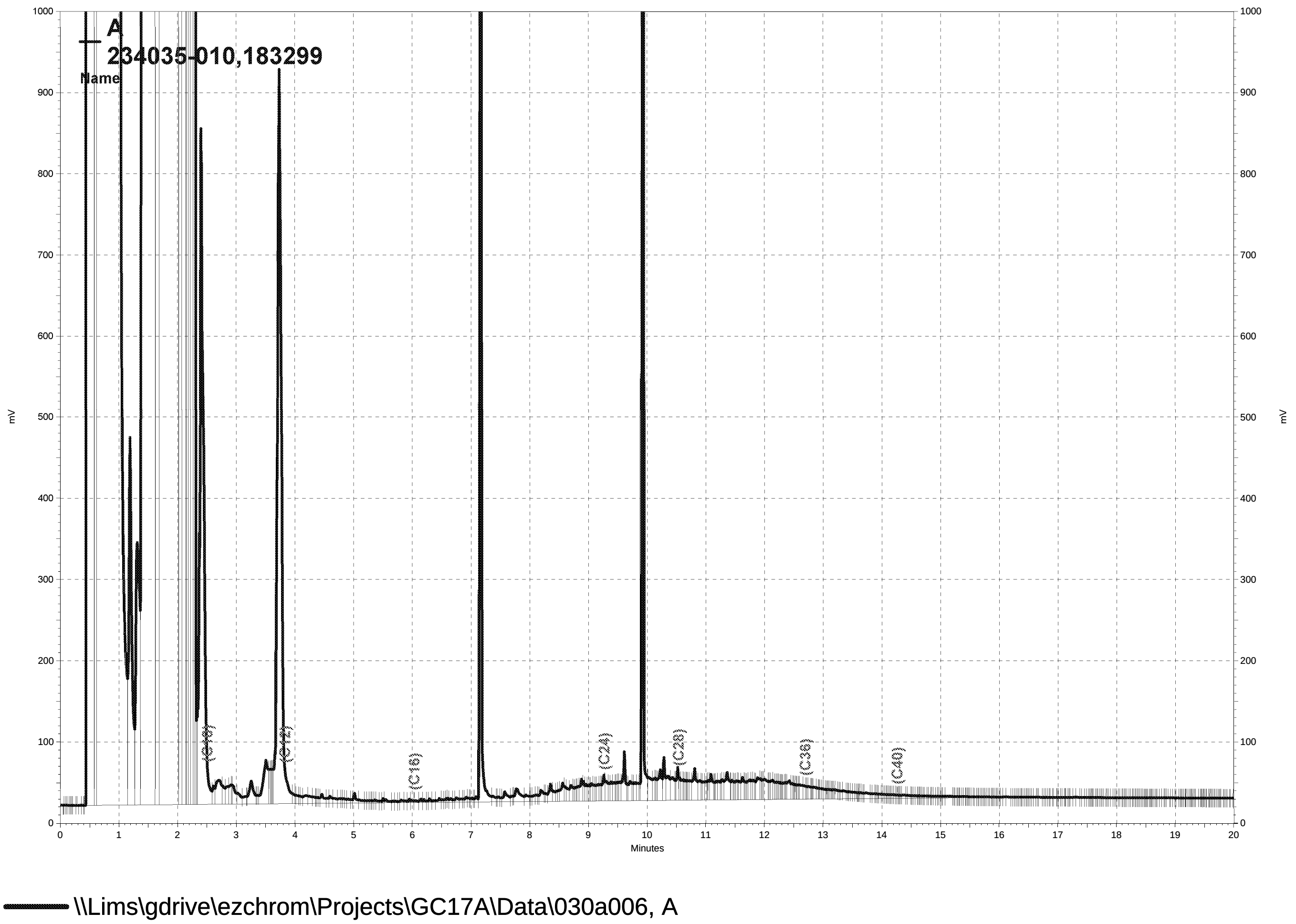
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200
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20
Minutes
(C10)
(C12)
(C16)
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(C40)
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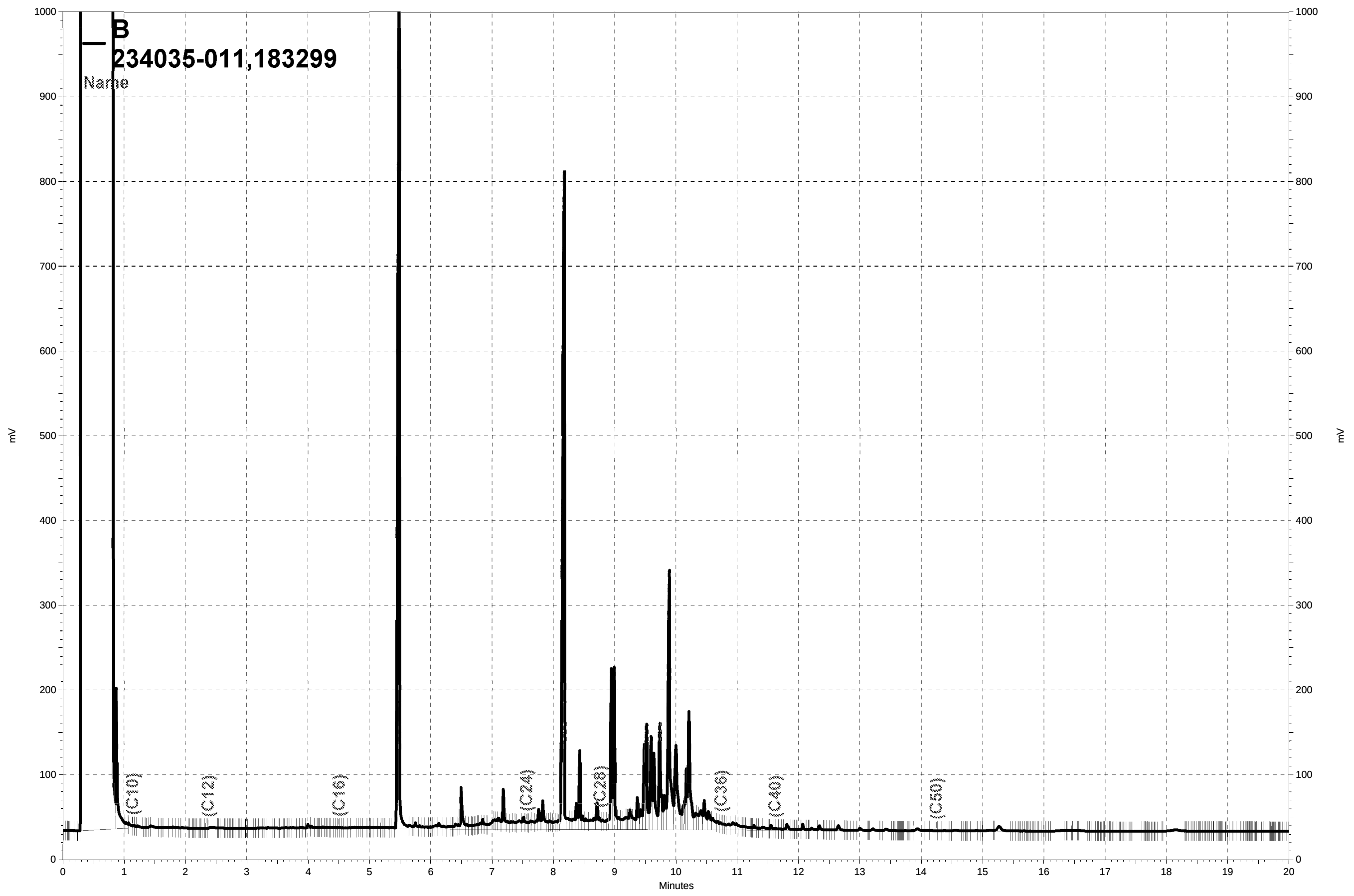

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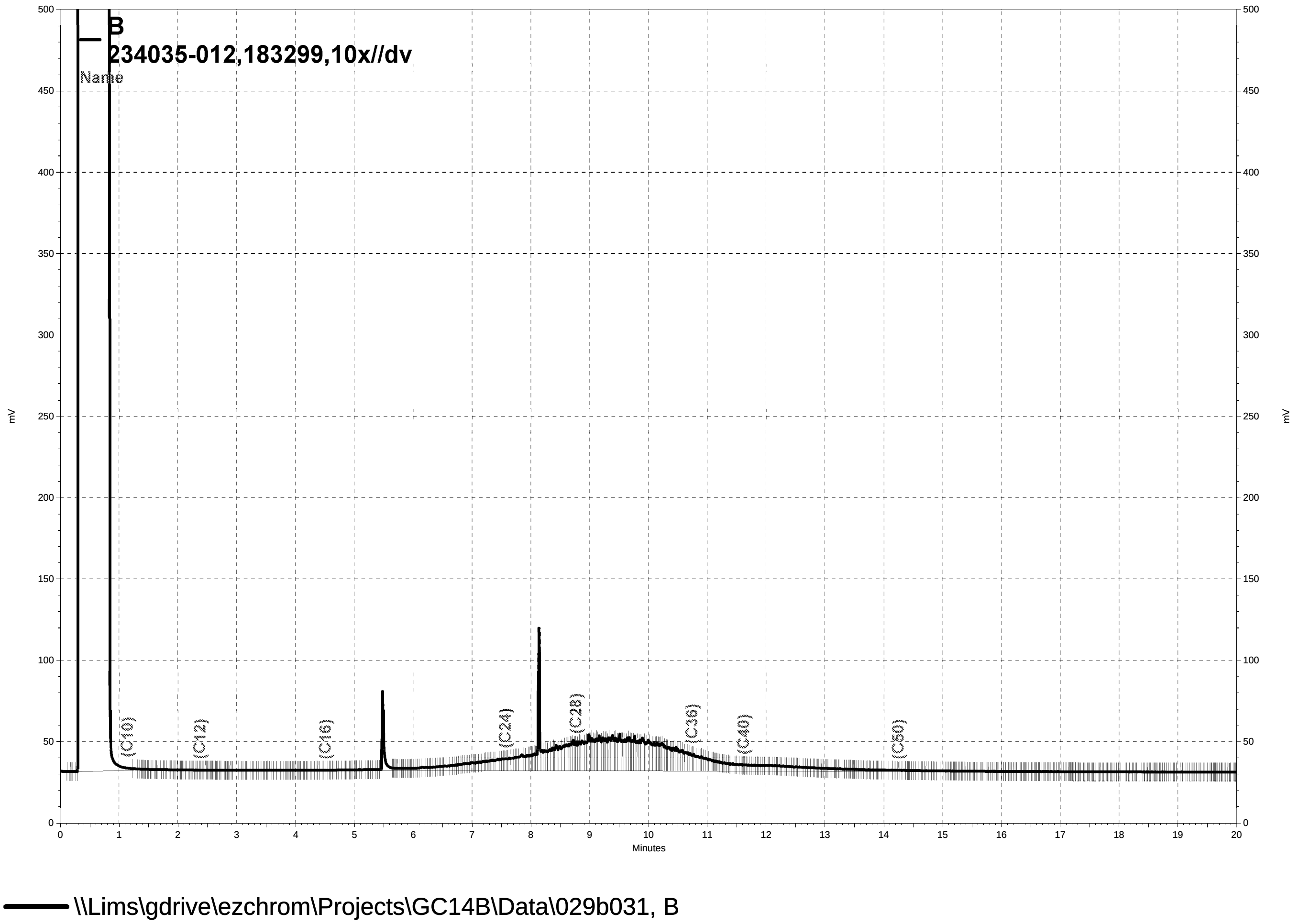
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200
150
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50
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(C10)
(C12)
(C16)
(C24)
(C28)
(C36)
(C40)
(C50)
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Minutes
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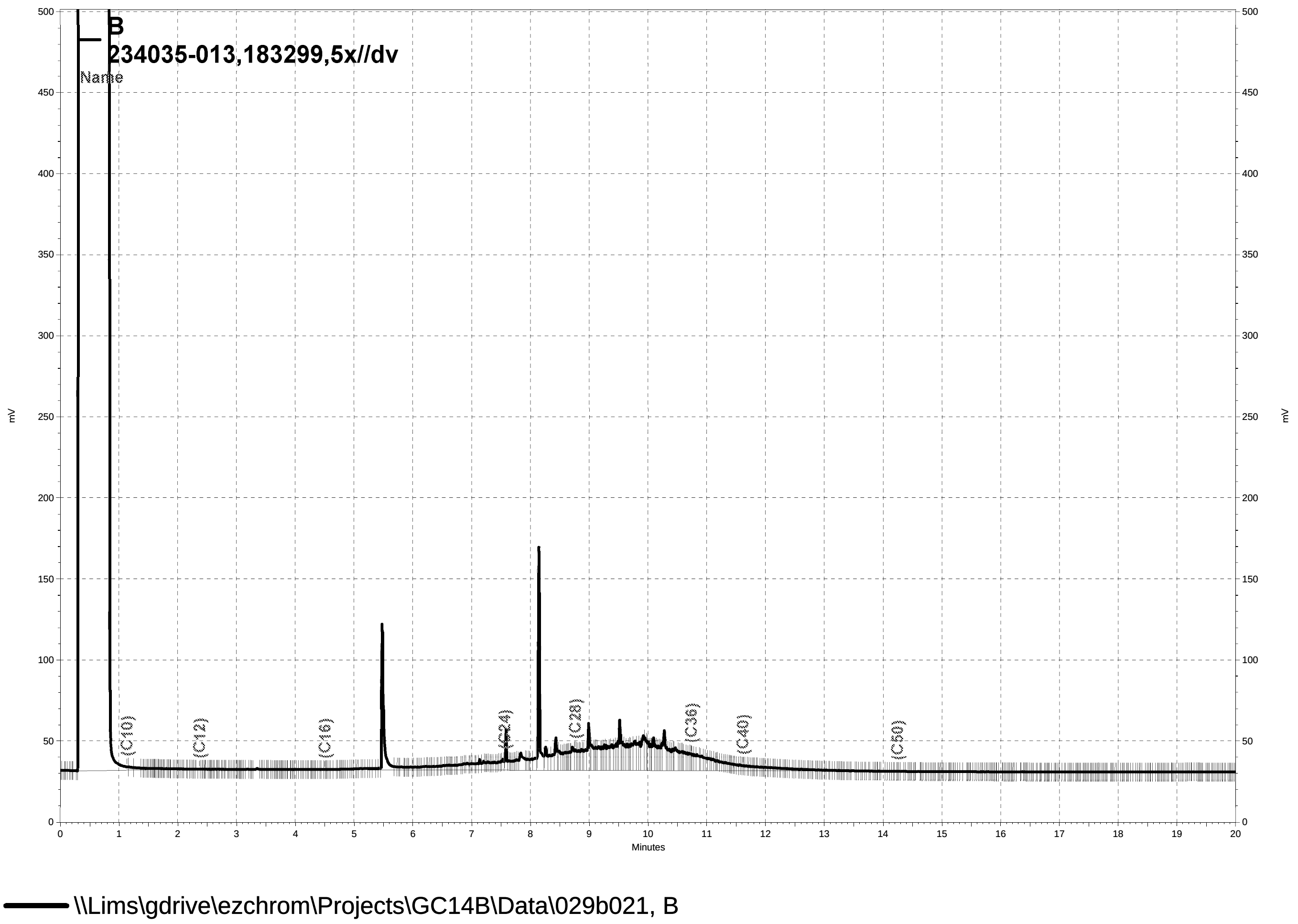
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(C12)
(C16)
(C24)
(C28)
(C36)
(C40)
(C50)
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250
300
350
400
450
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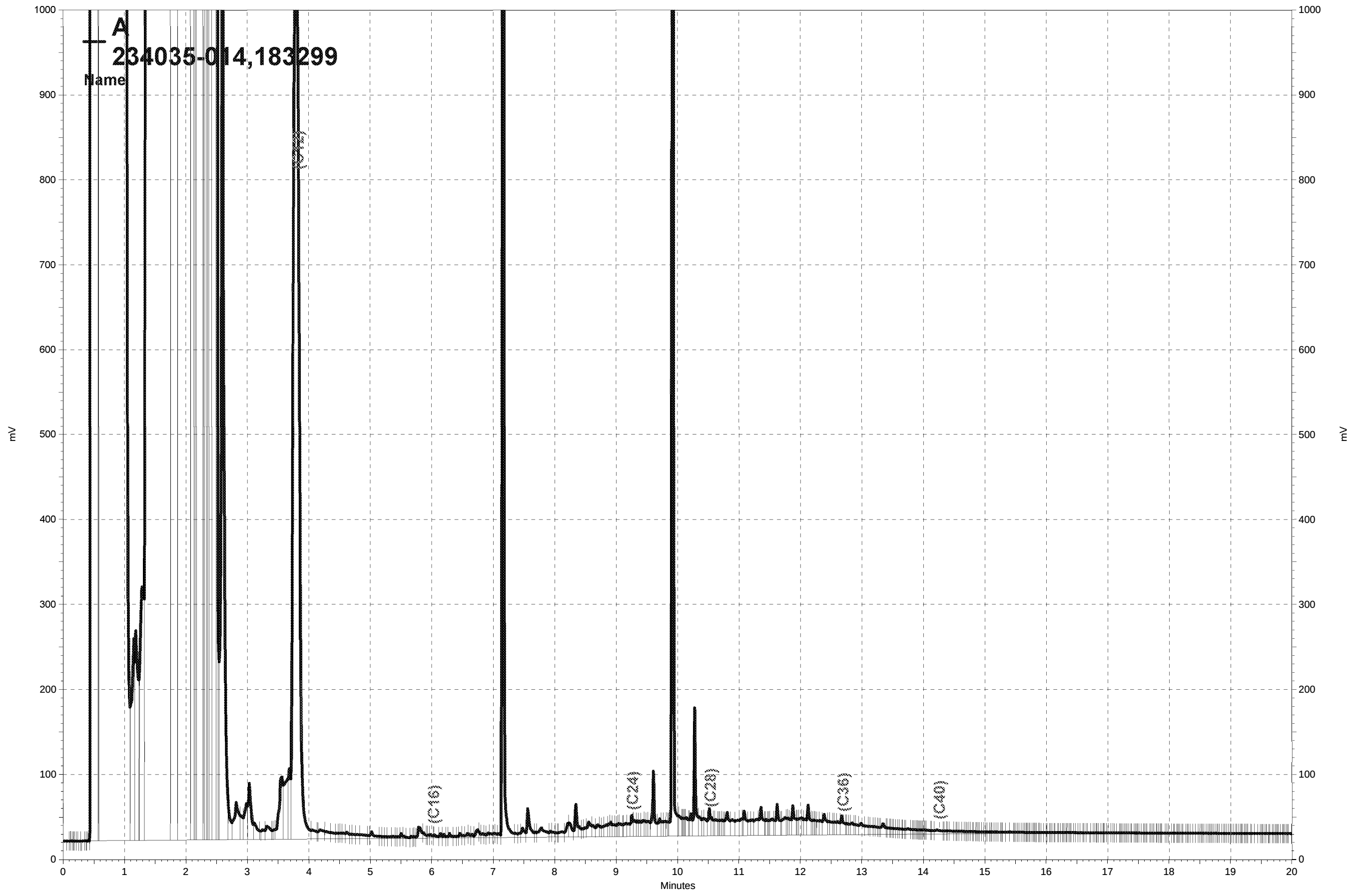

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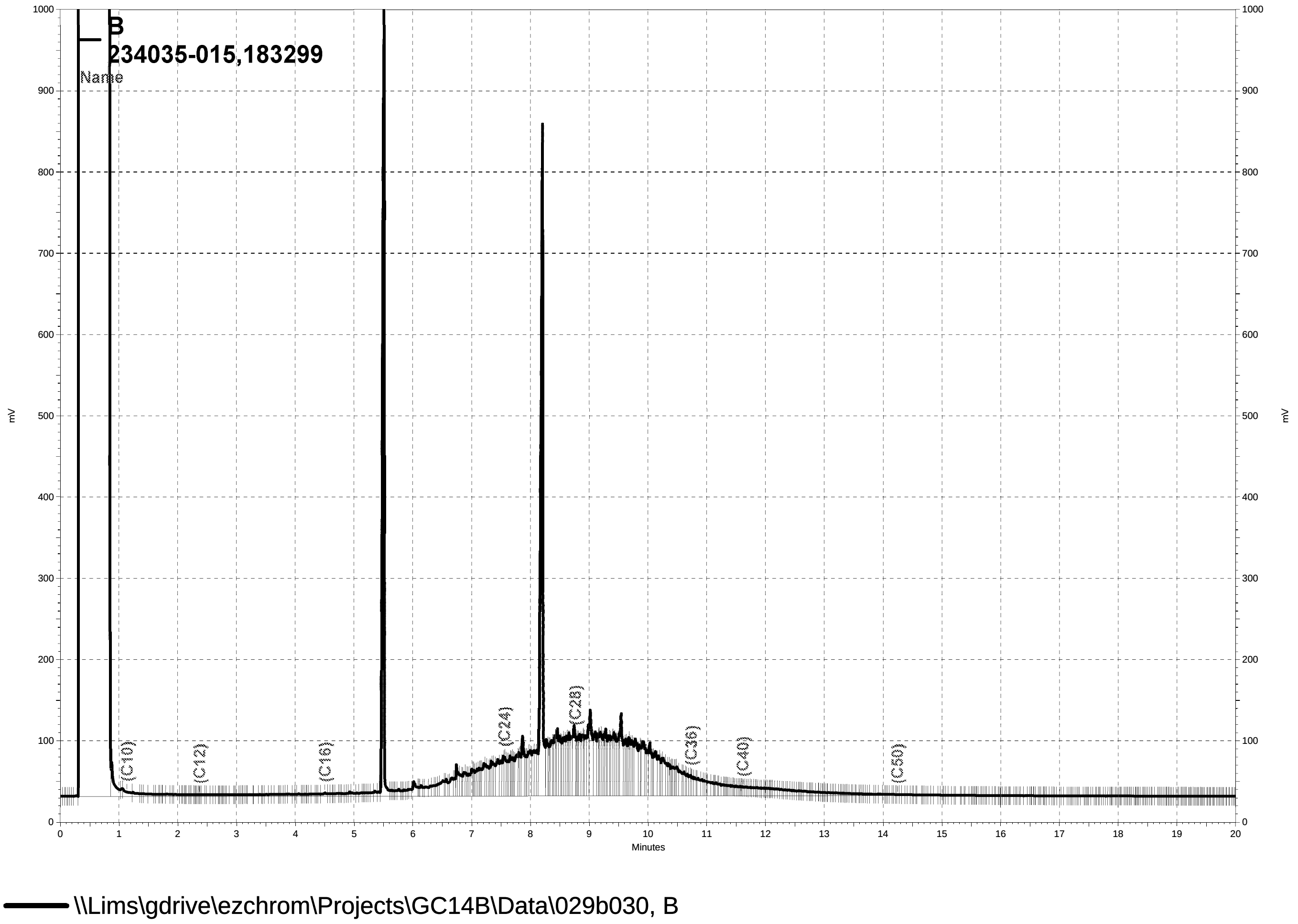
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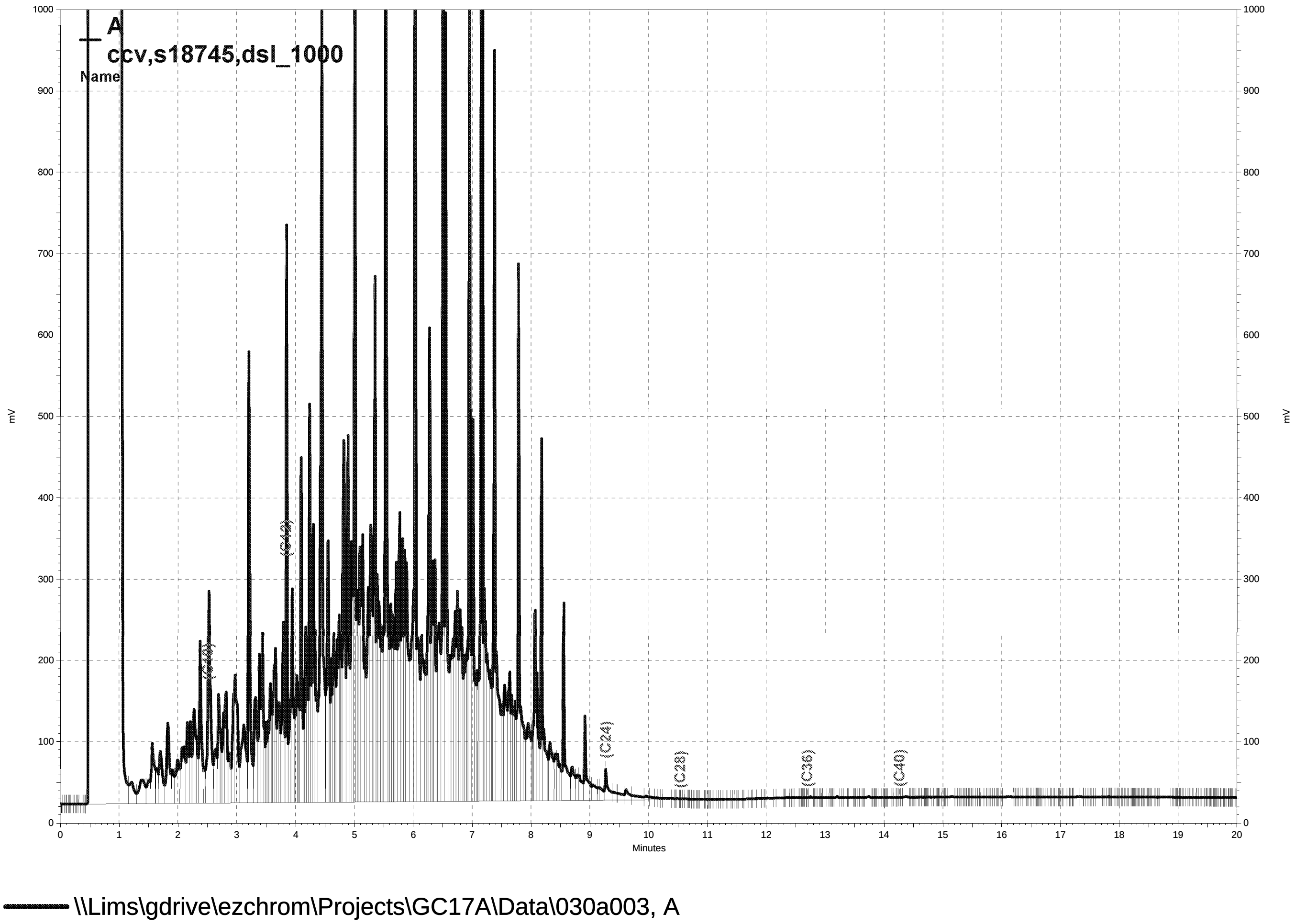
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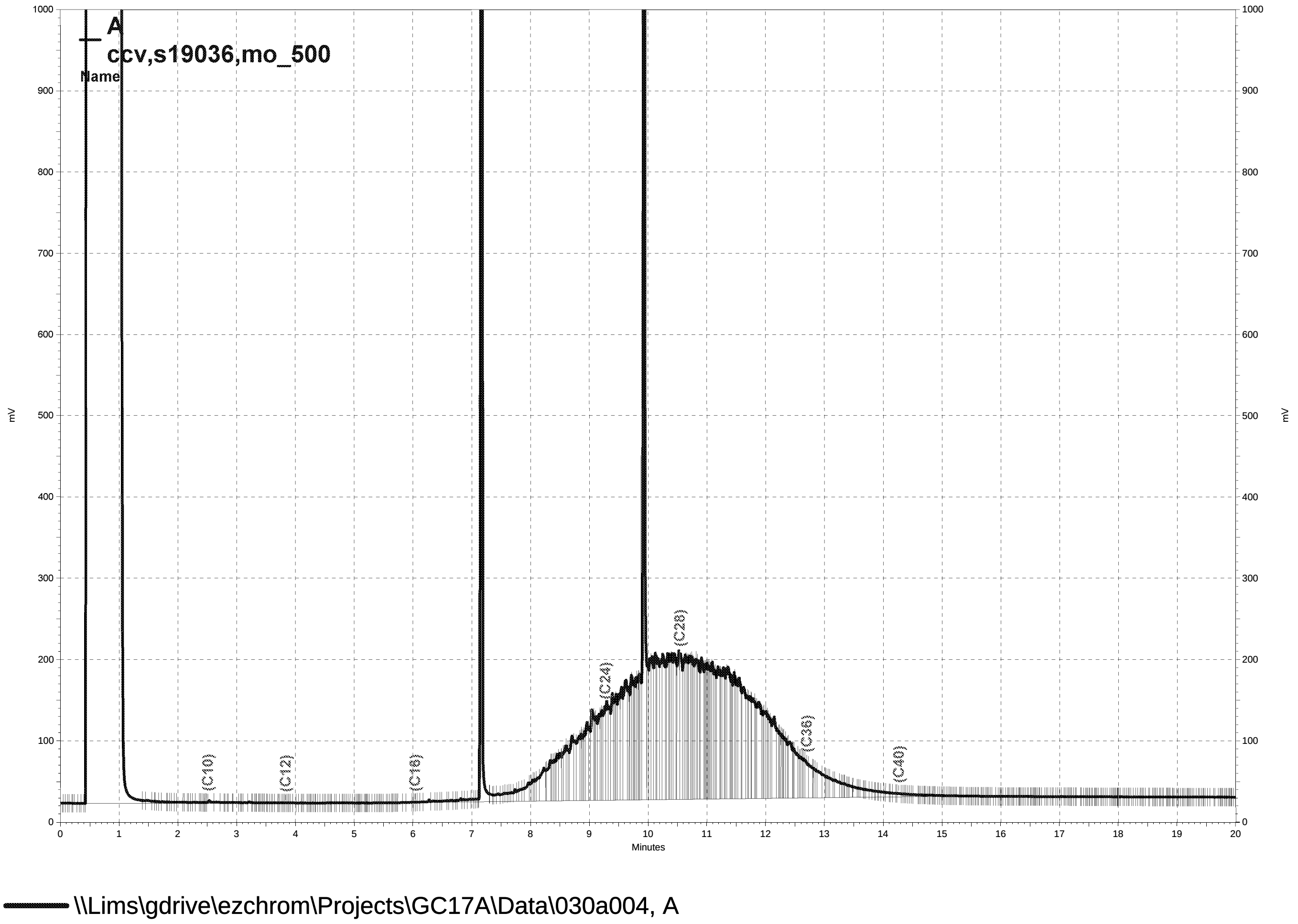A
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Organochlorine Pesticides

Lab #:	234035	Location:	Lower Llagas Creek
Client:	GEI Consultants, Inc.	Prep:	EPA 3550B
Project#:	115400	Analysis:	EPA 8081A
Field ID:	B-50+00W (1+2)	Batch#:	183275
Lab ID:	234035-001	Sampled:	01/26/12
Matrix:	Soil	Received:	01/26/12
Units:	ug/Kg	Prepared:	01/26/12
Basis:	as received	Analyzed:	01/27/12
Diln Fac:	1.000		

Analyte	Result	RL
alpha-BHC	ND	1.7
beta-BHC	ND	1.7
gamma-BHC	ND	1.7
delta-BHC	ND	1.7
Heptachlor	ND	1.7
Aldrin	ND	1.7
Heptachlor epoxide	ND	1.7
Endosulfan I	ND	1.7
Dieldrin	ND	3.3
4,4'-DDE	ND	3.3
Endrin	ND	3.3
Endosulfan II	ND	3.3
Endosulfan sulfate	ND	3.3
4,4'-DDD	ND	3.3
Endrin aldehyde	ND	3.3
4,4'-DDT	ND	3.3
alpha-Chlordane	ND	1.7
gamma-Chlordane	ND	1.7
Methoxychlor	ND	17
Toxaphene	ND	61

Surrogate	%REC	Limits
TCMX	71	53-121
Decachlorobiphenyl	69	39-120

ND= Not Detected
RL= Reporting Limit

Organochlorine Pesticides

Lab #:	234035	Location:	Lower Llagas Creek
Client:	GEI Consultants, Inc.	Prep:	EPA 3550B
Project#:	115400	Analysis:	EPA 8081A
Field ID:	B-59+00W (1+2)	Batch#:	183275
Lab ID:	234035-002	Sampled:	01/26/12
Matrix:	Soil	Received:	01/26/12
Units:	ug/Kg	Prepared:	01/26/12
Basis:	as received	Analyzed:	01/27/12
Diln Fac:	1.000		

Analyte	Result	RL
alpha-BHC	ND	1.7
beta-BHC	ND	1.7
gamma-BHC	ND	1.7
delta-BHC	ND	1.7
Heptachlor	ND	1.7
Aldrin	ND	1.7
Heptachlor epoxide	ND	1.7
Endosulfan I	ND	1.7
Dieldrin	ND	3.3
4,4'-DDE	ND	3.3
Endrin	ND	3.3
Endosulfan II	ND	3.3
Endosulfan sulfate	ND	3.3
4,4'-DDD	ND	3.3
Endrin aldehyde	ND	3.3
4,4'-DDT	ND	3.3
alpha-Chlordane	ND	1.7
gamma-Chlordane	ND	1.7
Methoxychlor	ND	17
Toxaphene	ND	59

Surrogate	%REC	Limits
TCMX	83	53-121
Decachlorobiphenyl	84	39-120

ND= Not Detected
RL= Reporting Limit

Organochlorine Pesticides

Lab #:	234035	Location:	Lower Llagas Creek
Client:	GEI Consultants, Inc.	Prep:	EPA 3550B
Project#:	115400	Analysis:	EPA 8081A
Field ID:	B-65+00E (1,2,3)	Batch#:	183275
Lab ID:	234035-003	Sampled:	01/26/12
Matrix:	Soil	Received:	01/26/12
Units:	ug/Kg	Prepared:	01/26/12
Basis:	as received	Analyzed:	01/27/12
Diln Fac:	1.000		

Analyte	Result	RL
alpha-BHC	ND	1.7
beta-BHC	ND	1.7
gamma-BHC	ND	1.7
delta-BHC	ND	1.7
Heptachlor	ND	1.7
Aldrin	ND	1.7
Heptachlor epoxide	ND	1.7
Endosulfan I	ND	1.7
Dieldrin	ND	3.3
4,4'-DDE	ND	3.3
Endrin	ND	3.3
Endosulfan II	ND	3.3
Endosulfan sulfate	ND	3.3
4,4'-DDD	ND	3.3
Endrin aldehyde	ND	3.3
4,4'-DDT	ND	3.3
alpha-Chlordane	ND	1.7
gamma-Chlordane	ND	1.7
Methoxychlor	ND	17
Toxaphene	ND	61

Surrogate	%REC	Limits
TCMX	75	53-121
Decachlorobiphenyl	88	39-120

ND= Not Detected
RL= Reporting Limit

Organochlorine Pesticides

Lab #:	234035	Location:	Lower Llagas Creek
Client:	GEI Consultants, Inc.	Prep:	EPA 3550B
Project#:	115400	Analysis:	EPA 8081A
Field ID:	B-127+00W (1,2)	Batch#:	183275
Lab ID:	234035-004	Sampled:	01/26/12
Matrix:	Soil	Received:	01/26/12
Units:	ug/Kg	Prepared:	01/26/12
Basis:	as received	Analyzed:	01/27/12
Diln Fac:	1.000		

Analyte	Result	RL
alpha-BHC	ND	1.7
beta-BHC	ND	1.7
gamma-BHC	ND	1.7
delta-BHC	ND	1.7
Heptachlor	ND	1.7
Aldrin	ND	1.7
Heptachlor epoxide	ND	1.7
Endosulfan I	ND	1.7
Dieldrin	ND	3.3
4,4'-DDE	5.5	3.3
Endrin	ND	3.3
Endosulfan II	ND	3.3
Endosulfan sulfate	ND	3.3
4,4'-DDD	ND	3.3
Endrin aldehyde	ND	3.3
4,4'-DDT	ND	3.3
alpha-Chlordane	ND	1.7
gamma-Chlordane	ND	1.7
Methoxychlor	ND	17
Toxaphene	ND	59

Surrogate	%REC	Limits
TCMX	30 *	53-121
Decachlorobiphenyl	75	39-120

*= Value outside of QC limits; see narrative
ND= Not Detected
RL= Reporting Limit

Organochlorine Pesticides

Lab #:	234035	Location:	Lower Llagas Creek
Client:	GEI Consultants, Inc.	Prep:	EPA 3550B
Project#:	115400	Analysis:	EPA 8081A
Field ID:	B-141+00W (1,2)	Batch#:	183275
Lab ID:	234035-005	Sampled:	01/26/12
Matrix:	Soil	Received:	01/26/12
Units:	ug/Kg	Prepared:	01/26/12
Basis:	as received	Analyzed:	01/27/12
Diln Fac:	1.000		

Analyte	Result	RL
alpha-BHC	ND	1.7
beta-BHC	ND	1.7
gamma-BHC	ND	1.7
delta-BHC	ND	1.7
Heptachlor	ND	1.7
Aldrin	ND	1.7
Heptachlor epoxide	ND	1.7
Endosulfan I	ND	1.7
Dieldrin	ND	3.3
4,4'-DDE	ND	3.3
Endrin	ND	3.3
Endosulfan II	ND	3.3
Endosulfan sulfate	ND	3.3
4,4'-DDD	ND	3.3
Endrin aldehyde	ND	3.3
4,4'-DDT	ND	3.3
alpha-Chlordane	ND	1.7
gamma-Chlordane	ND	1.7
Methoxychlor	ND	17
Toxaphene	ND	61

Surrogate	%REC	Limits
TCMX	39 *	53-121
Decachlorobiphenyl	81	39-120

*= Value outside of QC limits; see narrative
ND= Not Detected
RL= Reporting Limit

Organochlorine Pesticides

Lab #:	234035	Location:	Lower Llagas Creek
Client:	GEI Consultants, Inc.	Prep:	EPA 3550B
Project#:	115400	Analysis:	EPA 8081A
Field ID:	B-166+50E (1,2)	Batch#:	183275
Lab ID:	234035-006	Sampled:	01/26/12
Matrix:	Soil	Received:	01/26/12
Units:	ug/Kg	Prepared:	01/26/12
Basis:	as received	Analyzed:	01/27/12
Diln Fac:	1.000		

Analyte	Result	RL
alpha-BHC	ND	1.7
beta-BHC	ND	1.7
gamma-BHC	ND	1.7
delta-BHC	ND	1.7
Heptachlor	ND	1.7
Aldrin	ND	1.7
Heptachlor epoxide	ND	1.7
Endosulfan I	ND	1.7
Dieldrin	ND	3.3
4,4'-DDE	6.6	3.3
Endrin	ND	3.3
Endosulfan II	ND	3.3
Endosulfan sulfate	ND	3.3
4,4'-DDD	ND	3.3
Endrin aldehyde	ND	3.3
4,4'-DDT	ND	3.3
alpha-Chlordane	ND	1.7
gamma-Chlordane	ND	1.7
Methoxychlor	ND	17
Toxaphene	ND	59

Surrogate	%REC	Limits
TCMX	75	53-121
Decachlorobiphenyl	90	39-120

ND= Not Detected
RL= Reporting Limit

Organochlorine Pesticides

Lab #:	234035	Location:	Lower Llagas Creek
Client:	GEI Consultants, Inc.	Prep:	EPA 3550B
Project#:	115400	Analysis:	EPA 8081A
Field ID:	B-132+00W (1,2)	Batch#:	183275
Lab ID:	234035-007	Sampled:	01/26/12
Matrix:	Soil	Received:	01/26/12
Units:	ug/Kg	Prepared:	01/26/12
Basis:	as received	Analyzed:	01/27/12
Diln Fac:	1.000		

Analyte	Result	RL
alpha-BHC	ND	1.7
beta-BHC	ND	1.7
gamma-BHC	ND	1.7
delta-BHC	ND	1.7
Heptachlor	ND	1.7
Aldrin	ND	1.7
Heptachlor epoxide	ND	1.7
Endosulfan I	ND	1.7
Dieldrin	ND	3.3
4,4'-DDE	ND	3.3
Endrin	ND	3.3
Endosulfan II	ND	3.3
Endosulfan sulfate	ND	3.3
4,4'-DDD	ND	3.3
Endrin aldehyde	ND	3.3
4,4'-DDT	ND	3.3
alpha-Chlordane	ND	1.7
gamma-Chlordane	ND	1.7
Methoxychlor	ND	17
Toxaphene	ND	60

Surrogate	%REC	Limits
TCMX	82	53-121
Decachlorobiphenyl	90	39-120

ND= Not Detected
RL= Reporting Limit

Organochlorine Pesticides

Lab #:	234035	Location:	Lower Llagas Creek
Client:	GEI Consultants, Inc.	Prep:	EPA 3550B
Project#:	115400	Analysis:	EPA 8081A
Field ID:	B-173+50W (1,2)	Batch#:	183275
Lab ID:	234035-008	Sampled:	01/26/12
Matrix:	Soil	Received:	01/26/12
Units:	ug/Kg	Prepared:	01/26/12
Basis:	as received	Analyzed:	01/28/12
Diln Fac:	1.000		

Analyte	Result	RL
alpha-BHC	ND	1.7
beta-BHC	ND	1.7
gamma-BHC	ND	1.7
delta-BHC	ND	1.7
Heptachlor	ND	1.7
Aldrin	ND	1.7
Heptachlor epoxide	ND	1.7
Endosulfan I	ND	1.7
Dieldrin	ND	3.3
4,4'-DDE	ND	3.3
Endrin	ND	3.3
Endosulfan II	ND	3.3
Endosulfan sulfate	ND	3.3
4,4'-DDD	ND	3.3
Endrin aldehyde	ND	3.3
4,4'-DDT	ND	3.3
alpha-Chlordane	ND	1.7
gamma-Chlordane	ND	1.7
Methoxychlor	ND	17
Toxaphene	ND	61

Surrogate	%REC	Limits
TCMX	67	53-121
Decachlorobiphenyl	90	39-120

ND= Not Detected
RL= Reporting Limit

Organochlorine Pesticides

Lab #:	234035	Location:	Lower Llagas Creek
Client:	GEI Consultants, Inc.	Prep:	EPA 3550B
Project#:	115400	Analysis:	EPA 8081A
Field ID:	B-107+00W (1,2,3)	Batch#:	183275
Lab ID:	234035-009	Sampled:	01/26/12
Matrix:	Soil	Received:	01/26/12
Units:	ug/Kg	Prepared:	01/26/12
Basis:	as received	Analyzed:	01/28/12
Diln Fac:	1.000		

Analyte	Result	RL
alpha-BHC	ND	1.7
beta-BHC	ND	1.7
gamma-BHC	ND	1.7
delta-BHC	ND	1.7
Heptachlor	ND	1.7
Aldrin	ND	1.7
Heptachlor epoxide	ND	1.7
Endosulfan I	ND	1.7
Dieldrin	ND	3.3
4,4'-DDE	ND	3.3
Endrin	ND	3.3
Endosulfan II	ND	3.3
Endosulfan sulfate	ND	3.3
4,4'-DDD	ND	3.3
Endrin aldehyde	ND	3.3
4,4'-DDT	ND	3.3
alpha-Chlordane	ND	1.7
gamma-Chlordane	ND	1.7
Methoxychlor	ND	17
Toxaphene	ND	60

Surrogate	%REC	Limits
TCMX	73	53-121
Decachlorobiphenyl	57	39-120

ND= Not Detected
RL= Reporting Limit

Organochlorine Pesticides

Lab #:	234035	Location:	Lower Llagas Creek
Client:	GEI Consultants, Inc.	Prep:	EPA 3550B
Project#:	115400	Analysis:	EPA 8081A
Field ID:	B-92+50E (1,2,3)	Batch#:	183377
Lab ID:	234035-010	Sampled:	01/26/12
Matrix:	Soil	Received:	01/26/12
Units:	ug/Kg	Prepared:	01/31/12
Basis:	as received	Analyzed:	01/31/12
Diln Fac:	1.000		

Analyte	Result	RL
alpha-BHC	ND	1.7
beta-BHC	ND	1.7
gamma-BHC	ND	1.7
delta-BHC	ND	1.7
Heptachlor	ND	1.7
Aldrin	ND	1.7
Heptachlor epoxide	ND	1.7
Endosulfan I	ND	1.7
Dieldrin	ND	3.3
4,4'-DDE	8.0 C	3.3
Endrin	ND	3.3
Endosulfan II	ND	3.3
Endosulfan sulfate	ND	3.3
4,4'-DDD	ND	3.3
Endrin aldehyde	ND	3.3
4,4'-DDT	ND #	3.3
alpha-Chlordane	ND	1.7
gamma-Chlordane	ND	1.7
Methoxychlor	ND	17
Toxaphene	ND	60

Surrogate	%REC	Limits
TCMX	65	53-121
Decachlorobiphenyl	69	39-120

#= CCV drift outside limits; average CCV drift within limits per method requirements
C= Presence confirmed, but RPD between columns exceeds 40%
ND= Not Detected
RL= Reporting Limit

Organochlorine Pesticides

Lab #:	234035	Location:	Lower Llagas Creek
Client:	GEI Consultants, Inc.	Prep:	EPA 3550B
Project#:	115400	Analysis:	EPA 8081A
Field ID:	B-116+50E (1,2,3)	Batch#:	183377
Lab ID:	234035-011	Sampled:	01/26/12
Matrix:	Soil	Received:	01/26/12
Units:	ug/Kg	Prepared:	01/31/12
Basis:	as received	Analyzed:	01/31/12
Diln Fac:	1.000		

Analyte	Result	RL
alpha-BHC	ND	1.7
beta-BHC	ND	1.7
gamma-BHC	ND	1.7
delta-BHC	ND	1.7
Heptachlor	ND	1.7
Aldrin	ND	1.7
Heptachlor epoxide	ND	1.7
Endosulfan I	ND	1.7
Dieldrin	ND	3.3
4,4'-DDE	ND	3.3
Endrin	ND	3.3
Endosulfan II	ND	3.3
Endosulfan sulfate	ND	3.3
4,4'-DDD	ND	3.3
Endrin aldehyde	ND	3.3
4,4'-DDT	ND #	3.3
alpha-Chlordane	ND	1.7
gamma-Chlordane	ND	1.7
Methoxychlor	ND	17
Toxaphene	ND	60

Surrogate	%REC	Limits
TCMX	68	53-121
Decachlorobiphenyl	67	39-120

#= CCV drift outside limits; average CCV drift within limits per method requirements
ND= Not Detected
RL= Reporting Limit

Organochlorine Pesticides

Lab #:	234035	Location:	Lower Llagas Creek
Client:	GEI Consultants, Inc.	Prep:	EPA 3550B
Project#:	115400	Analysis:	EPA 8081A
Field ID:	B-92+50W (1,2)	Batch#:	183377
Lab ID:	234035-012	Sampled:	01/26/12
Matrix:	Soil	Received:	01/26/12
Units:	ug/Kg	Prepared:	01/31/12
Basis:	as received	Analyzed:	01/31/12
Diln Fac:	3.000		

Analyte	Result	RL
alpha-BHC	ND	5.1
beta-BHC	ND	5.1
gamma-BHC	ND	5.1
delta-BHC	ND	5.1
Heptachlor	ND	5.1
Aldrin	ND	5.1
Heptachlor epoxide	ND	5.1
Endosulfan I	ND	5.1
Dieldrin	ND	9.9
4,4'-DDE	ND	9.9
Endrin	ND	9.9
Endosulfan II	ND	9.9
Endosulfan sulfate	ND	9.9
4,4'-DDD	ND	9.9
Endrin aldehyde	ND	9.9
4,4'-DDT	ND #	9.9
alpha-Chlordane	ND	5.1
gamma-Chlordane	ND	5.1
Methoxychlor	ND	51
Toxaphene	ND	180

Surrogate	%REC	Limits
TCMX	78	53-121
Decachlorobiphenyl	44	39-120

#= CCV drift outside limits; average CCV drift within limits per method requirements
ND= Not Detected
RL= Reporting Limit

Organochlorine Pesticides

Lab #:	234035	Location:	Lower Llagas Creek
Client:	GEI Consultants, Inc.	Prep:	EPA 3550B
Project#:	115400	Analysis:	EPA 8081A
Field ID:	B-78+00W (1,2)	Batch#:	183377
Lab ID:	234035-013	Sampled:	01/26/12
Matrix:	Soil	Received:	01/26/12
Units:	ug/Kg	Prepared:	01/31/12
Basis:	as received	Analyzed:	01/31/12
Diln Fac:	1.000		

Analyte	Result	RL
alpha-BHC	ND	1.7
beta-BHC	ND	1.7
gamma-BHC	ND	1.7
delta-BHC	1.9 C	1.7
Heptachlor	ND	1.7
Aldrin	ND	1.7
Heptachlor epoxide	ND	1.7
Endosulfan I	ND	1.7
Dieldrin	4.1	3.3
4,4'-DDE	12	3.3
Endrin	ND	3.3
Endosulfan II	ND	3.3
Endosulfan sulfate	ND	3.3
4,4'-DDD	4.9	3.3
Endrin aldehyde	ND	3.3
4,4'-DDT	ND #	3.3
alpha-Chlordane	ND	1.7
gamma-Chlordane	ND	1.7
Methoxychlor	ND	17
Toxaphene	ND	60

Surrogate	%REC	Limits
TCMX	75	53-121
Decachlorobiphenyl	56	39-120

#= CCV drift outside limits; average CCV drift within limits per method requirements
C= Presence confirmed, but RPD between columns exceeds 40%
ND= Not Detected
RL= Reporting Limit

Organochlorine Pesticides

Lab #:	234035	Location:	Lower Llagas Creek
Client:	GEI Consultants, Inc.	Prep:	EPA 3550B
Project#:	115400	Analysis:	EPA 8081A
Field ID:	B-132+50E (1,2)	Batch#:	183377
Lab ID:	234035-014	Sampled:	01/26/12
Matrix:	Soil	Received:	01/26/12
Units:	ug/Kg	Prepared:	01/31/12
Basis:	as received	Analyzed:	01/31/12
Diln Fac:	1.000		

Analyte	Result	RL
alpha-BHC	ND	1.7
beta-BHC	ND	1.7
gamma-BHC	ND	1.7
delta-BHC	ND	1.7
Heptachlor	ND	1.7
Aldrin	ND	1.7
Heptachlor epoxide	ND	1.7
Endosulfan I	ND	1.7
Dieldrin	ND	3.3
4,4'-DDE	ND	3.3
Endrin	ND	3.3
Endosulfan II	ND	3.3
Endosulfan sulfate	ND	3.3
4,4'-DDD	ND	3.3
Endrin aldehyde	ND	3.3
4,4'-DDT	ND #	3.3
alpha-Chlordane	ND	1.7
gamma-Chlordane	ND	1.7
Methoxychlor	ND	17
Toxaphene	ND	59

Surrogate	%REC	Limits
TCMX	68	53-121
Decachlorobiphenyl	71	39-120

#= CCV drift outside limits; average CCV drift within limits per method requirements
ND= Not Detected
RL= Reporting Limit

Organochlorine Pesticides

Lab #:	234035	Location:	Lower Llagas Creek
Client:	GEI Consultants, Inc.	Prep:	EPA 3550B
Project#:	115400	Analysis:	EPA 8081A
Field ID:	B-148+00E (1,2)	Batch#:	183377
Lab ID:	234035-015	Sampled:	01/26/12
Matrix:	Soil	Received:	01/26/12
Units:	ug/Kg	Prepared:	01/31/12
Basis:	as received	Analyzed:	01/31/12
Diln Fac:	1.000		

Analyte	Result	RL
alpha-BHC	ND	1.7
beta-BHC	ND	1.7
gamma-BHC	ND	1.7
delta-BHC	ND	1.7
Heptachlor	ND	1.7
Aldrin	ND	1.7
Heptachlor epoxide	ND	1.7
Endosulfan I	ND	1.7
Dieldrin	3.4	3.3
4,4'-DDE	15	3.3
Endrin	ND	3.3
Endosulfan II	ND	3.3
Endosulfan sulfate	ND	3.3
4,4'-DDD	ND	3.3
Endrin aldehyde	ND	3.3
4,4'-DDT	ND #	3.3
alpha-Chlordane	ND	1.7
gamma-Chlordane	ND	1.7
Methoxychlor	ND	17
Toxaphene	ND	59

Surrogate	%REC	Limits
TCMX	72	53-121
Decachlorobiphenyl	59	39-120

#= CCV drift outside limits; average CCV drift within limits per method requirements
ND= Not Detected
RL= Reporting Limit

Batch QC Report

Organochlorine Pesticides

Lab #:	234035	Location:	Lower Llagas Creek
Client:	GEI Consultants, Inc.	Prep:	EPA 3550B
Project#:	115400	Analysis:	EPA 8081A
Type:	BLANK	Diln Fac:	1.000
Lab ID:	QC626627	Batch#:	183275
Matrix:	Soil	Prepared:	01/26/12
Units:	ug/Kg	Analyzed:	01/30/12

Analyte	Result	RL
alpha-BHC	ND	1.7
beta-BHC	ND	1.7
gamma-BHC	ND	1.7
delta-BHC	ND	1.7
Heptachlor	ND	1.7
Aldrin	ND	1.7
Heptachlor epoxide	ND	1.7
Endosulfan I	ND	1.7
Dieldrin	ND	3.3
4,4'-DDE	ND	3.3
Endrin	ND	3.3
Endosulfan II	ND	3.3
Endosulfan sulfate	ND	3.3
4,4'-DDD	ND	3.3
Endrin aldehyde	ND	3.3
4,4'-DDT	ND #	3.3
alpha-Chlordane	ND	1.7
gamma-Chlordane	ND	1.7
Methoxychlor	ND	17
Toxaphene	ND	59

Surrogate	%REC	Limits
TCMX	78	53-121
Decachlorobiphenyl	84	39-120

#= CCV drift outside limits; average CCV drift within limits per method requirements

ND= Not Detected

RL= Reporting Limit

Batch QC Report

Organochlorine Pesticides

Lab #:	234035	Location:	Lower Llagas Creek
Client:	GEI Consultants, Inc.	Prep:	EPA 3550B
Project#:	115400	Analysis:	EPA 8081A
Type:	LCS	Diln Fac:	1.000
Lab ID:	QC626631	Batch#:	183275
Matrix:	Soil	Prepared:	01/26/12
Units:	ug/Kg	Analyzed:	01/27/12

Analyte	Spiked	Result	%REC	Limits
gamma-BHC	13.42	10.68	80	53-120
Heptachlor	13.42	11.35	85	44-120
Aldrin	13.42	10.75	80	50-120
Dieldrin	26.85	25.85	96	47-129
Endrin	26.85	20.88	78	47-127
4,4'-DDT	26.85	26.97	100	51-127

Surrogate	%REC	Limits
TCMX	72	53-121
Decachlorobiphenyl	100	39-120

Batch QC Report

Organochlorine Pesticides

Lab #:	234035	Location:	Lower Llagas Creek
Client:	GEI Consultants, Inc.	Prep:	EPA 3550B
Project#:	115400	Analysis:	EPA 8081A
Field ID:	ZZZZZZZZZZ	Batch#:	183275
MSS Lab ID:	234046-001	Sampled:	01/26/12
Matrix:	Soil	Received:	01/26/12
Units:	ug/Kg	Prepared:	01/26/12
Basis:	as received	Analyzed:	01/29/12
Diln Fac:	1.000		

Type: MS

Lab ID: QC626632

Analyte	MSS Result	Spiked	Result	%REC	Limits
gamma-BHC	<0.2189	13.55	12.36	91	58-120
Heptachlor	<0.1941	13.55	11.50	85	52-120
Aldrin	<0.2075	13.55	11.35	84	54-120
Dieldrin	<0.4032	27.10	23.86	88	51-120
Endrin	1.156	27.10	24.05	84	51-124
4,4'-DDT	2.600	27.10	26.21	87	50-124

Surrogate	%REC	Limits
TCMX	81	53-121
Decachlorobiphenyl	82	39-120

Type: MSD

Lab ID: QC626633

Analyte	Spiked	Result	%REC	Limits	RPD	Lim
gamma-BHC	13.44	12.05	90	58-120	2	28
Heptachlor	13.44	11.04	82	52-120	3	30
Aldrin	13.44	11.15	83	54-120	1	35
Dieldrin	26.88	23.70	88	51-120	0	23
Endrin	26.88	23.71	84	51-124	1	31
4,4'-DDT	26.88	26.47	89	50-124	2	28

Surrogate	%REC	Limits
TCMX	78	53-121
Decachlorobiphenyl	84	39-120

RPD= Relative Percent Difference

Batch QC Report

Organochlorine Pesticides

Lab #:	234035	Location:	Lower Llagas Creek
Client:	GEI Consultants, Inc.	Prep:	EPA 3550B
Project#:	115400	Analysis:	EPA 8081A
Type:	BLANK	Diln Fac:	1.000
Lab ID:	QC627083	Batch#:	183377
Matrix:	Soil	Prepared:	01/31/12
Units:	ug/Kg	Analyzed:	01/31/12

Analyte	Result	RL
alpha-BHC	ND	1.7
beta-BHC	ND	1.7
gamma-BHC	ND	1.7
delta-BHC	ND	1.7
Heptachlor	ND	1.7
Aldrin	ND	1.7
Heptachlor epoxide	ND	1.7
Endosulfan I	ND	1.7
Dieldrin	ND	3.3
4,4'-DDE	ND	3.3
Endrin	ND	3.3
Endosulfan II	ND	3.3
Endosulfan sulfate	ND	3.3
4,4'-DDD	ND	3.3
Endrin aldehyde	ND	3.3
4,4'-DDT	ND #	3.3
alpha-Chlordane	ND	1.7
gamma-Chlordane	ND	1.7
Methoxychlor	ND	17
Toxaphene	ND	59

Surrogate	%REC	Limits
TCMX	69	53-121
Decachlorobiphenyl	79	39-120

#= CCV drift outside limits; average CCV drift within limits per method requirements

ND= Not Detected

RL= Reporting Limit

Batch QC Report

Organochlorine Pesticides

Lab #:	234035	Location:	Lower Llagas Creek
Client:	GEI Consultants, Inc.	Prep:	EPA 3550B
Project#:	115400	Analysis:	EPA 8081A
Type:	LCS	Diln Fac:	1.000
Lab ID:	QC627087	Batch#:	183377
Matrix:	Soil	Prepared:	01/31/12
Units:	ug/Kg	Analyzed:	01/31/12

Analyte	Spiked	Result	%REC	Limits
gamma-BHC	13.32	11.16	84	53-120
Heptachlor	13.32	12.59	95	44-120
Aldrin	13.32	10.96	82	50-120
Dieldrin	26.64	24.96	94	47-129
Endrin	26.64	24.96	94	47-127
4,4'-DDT	26.64	22.95 #	86	51-127

Surrogate	%REC	Limits
TCMX	81	53-121
Decachlorobiphenyl	91	39-120

#= CCV drift outside limits; average CCV drift within limits per method requirements

Batch QC Report

Organochlorine Pesticides

Lab #:	234035	Location:	Lower Llagas Creek
Client:	GEI Consultants, Inc.	Prep:	EPA 3550B
Project#:	115400	Analysis:	EPA 8081A
Field ID:	ZZZZZZZZZZ	Batch#:	183377
MSS Lab ID:	234105-002	Sampled:	01/30/12
Matrix:	Soil	Received:	01/30/12
Units:	ug/Kg	Prepared:	01/31/12
Basis:	as received	Analyzed:	01/31/12
Diln Fac:	3.000		

Type: MS

Lab ID: QC627088

Analyte	MSS Result	Spiked	Result	%REC	Limits
gamma-BHC	1.353	13.19	11.64	78	58-120
Heptachlor	<0.5820	13.19	11.50	87	52-120
Aldrin	6.253	13.19	14.69	64	54-120
Dieldrin	7.566	26.38	28.81	81	51-120
Endrin	9.189	26.38	29.18	76	51-124
4,4'-DDT	154.8	26.38	151.5 #	-12 NM	50-124

Surrogate	%REC	Limits
TCMX	79	53-121
Decachlorobiphenyl	63	39-120

Type: MSD

Lab ID: QC627089

Analyte	Spiked	Result	%REC	Limits	RPD	Lim
gamma-BHC	13.16	12.89	88	58-120	10	28
Heptachlor	13.16	12.50	95	52-120	9	30
Aldrin	13.16	15.31	69	54-120	4	35
Dieldrin	26.32	31.05	89	51-120	8	23
Endrin	26.32	30.34	80	51-124	4	31
4,4'-DDT	26.32	201.4 >LR #	177 NM	50-124	NC	28

Surrogate	%REC	Limits
TCMX	85	53-121
Decachlorobiphenyl	85	39-120

#= CCV drift outside limits; average CCV drift within limits per method requirements
NC= Not Calculated
NM= Not Meaningful: Sample concentration > 4X spike concentration
>LR= Response exceeds instrument's linear range
RPD= Relative Percent Difference

California Title 22 Metals

Lab #:	234035	Project#:	115400
Client:	GEI Consultants, Inc.	Location:	Lower Llagas Creek
Field ID:	B-50+00W (1+2)	Basis:	as received
Lab ID:	234035-001	Diln Fac:	1.000
Matrix:	Soil	Sampled:	01/26/12
Units:	mg/Kg	Received:	01/26/12

Analyte	Result	RL	Batch#	Prepared	Analyzed	Prep	Analysis
Antimony	ND	0.54	183354	01/30/12	01/31/12	EPA 3050B	EPA 6010B
Arsenic	3.3	0.27	183354	01/30/12	01/30/12	EPA 3050B	EPA 6010B
Barium	200	0.27	183354	01/30/12	01/30/12	EPA 3050B	EPA 6010B
Beryllium	0.44	0.11	183354	01/30/12	01/30/12	EPA 3050B	EPA 6010B
Cadmium	ND	0.27	183354	01/30/12	01/30/12	EPA 3050B	EPA 6010B
Chromium	91	0.27	183354	01/30/12	01/30/12	EPA 3050B	EPA 6010B
Cobalt	17	0.27	183354	01/30/12	01/30/12	EPA 3050B	EPA 6010B
Copper	34	0.27	183354	01/30/12	01/30/12	EPA 3050B	EPA 6010B
Lead	4.9	0.27	183354	01/30/12	01/31/12	EPA 3050B	EPA 6010B
Mercury	0.049	0.018	183290	01/27/12	01/27/12	METHOD	EPA 7471A
Molybdenum	0.50	0.27	183354	01/30/12	01/31/12	EPA 3050B	EPA 6010B
Nickel	120	0.27	183354	01/30/12	01/30/12	EPA 3050B	EPA 6010B
Selenium	ND	0.54	183354	01/30/12	01/30/12	EPA 3050B	EPA 6010B
Silver	0.59	0.27	183354	01/30/12	01/30/12	EPA 3050B	EPA 6010B
Thallium	ND	0.54	183354	01/30/12	01/30/12	EPA 3050B	EPA 6010B
Vanadium	62	0.27	183354	01/30/12	01/30/12	EPA 3050B	EPA 6010B
Zinc	49	1.1	183354	01/30/12	01/30/12	EPA 3050B	EPA 6010B

ND= Not Detected
RL= Reporting Limit

California Title 22 Metals

Lab #:	234035	Project#:	115400
Client:	GEI Consultants, Inc.	Location:	Lower Llagas Creek
Field ID:	B-59+00W (1+2)	Basis:	as received
Lab ID:	234035-002	Diln Fac:	1.000
Matrix:	Soil	Sampled:	01/26/12
Units:	mg/Kg	Received:	01/26/12

Analyte	Result	RL	Batch#	Prepared	Analyzed	Prep	Analysis
Antimony	ND	0.47	183354	01/30/12	01/31/12	EPA 3050B	EPA 6010B
Arsenic	3.0	0.24	183354	01/30/12	01/30/12	EPA 3050B	EPA 6010B
Barium	200	0.24	183354	01/30/12	01/30/12	EPA 3050B	EPA 6010B
Beryllium	0.59	0.094	183354	01/30/12	01/30/12	EPA 3050B	EPA 6010B
Cadmium	0.24	0.24	183354	01/30/12	01/30/12	EPA 3050B	EPA 6010B
Chromium	88	0.24	183354	01/30/12	01/30/12	EPA 3050B	EPA 6010B
Cobalt	19	0.24	183354	01/30/12	01/30/12	EPA 3050B	EPA 6010B
Copper	40	0.24	183354	01/30/12	01/30/12	EPA 3050B	EPA 6010B
Lead	5.4	0.24	183354	01/30/12	01/31/12	EPA 3050B	EPA 6010B
Mercury	0.064	0.018	183290	01/27/12	01/27/12	METHOD	EPA 7471A
Molybdenum	0.43	0.24	183354	01/30/12	01/30/12	EPA 3050B	EPA 6010B
Nickel	120	0.24	183354	01/30/12	01/30/12	EPA 3050B	EPA 6010B
Selenium	ND	0.47	183354	01/30/12	01/30/12	EPA 3050B	EPA 6010B
Silver	0.61	0.24	183354	01/30/12	01/30/12	EPA 3050B	EPA 6010B
Thallium	ND	0.47	183354	01/30/12	01/30/12	EPA 3050B	EPA 6010B
Vanadium	69	0.24	183354	01/30/12	01/30/12	EPA 3050B	EPA 6010B
Zinc	60	0.94	183354	01/30/12	01/30/12	EPA 3050B	EPA 6010B

ND= Not Detected
RL= Reporting Limit

California Title 22 Metals

Lab #:	234035	Project#:	115400
Client:	GEI Consultants, Inc.	Location:	Lower Llagas Creek
Field ID:	B-65+00E (1,2,3)	Basis:	as received
Lab ID:	234035-003	Diln Fac:	1.000
Matrix:	Soil	Sampled:	01/26/12
Units:	mg/Kg	Received:	01/26/12

Analyte	Result	RL	Batch#	Prepared	Analyzed	Prep	Analysis
Antimony	ND	0.49	183354	01/30/12	01/30/12	EPA 3050B	EPA 6010B
Arsenic	2.8	0.24	183354	01/30/12	01/30/12	EPA 3050B	EPA 6010B
Barium	45	0.24	183354	01/30/12	01/30/12	EPA 3050B	EPA 6010B
Beryllium	0.19	0.097	183354	01/30/12	01/30/12	EPA 3050B	EPA 6010B
Cadmium	ND	0.24	183354	01/30/12	01/30/12	EPA 3050B	EPA 6010B
Chromium	23	0.24	183354	01/30/12	01/30/12	EPA 3050B	EPA 6010B
Cobalt	3.6	0.24	183354	01/30/12	01/30/12	EPA 3050B	EPA 6010B
Copper	10	0.24	183354	01/30/12	01/30/12	EPA 3050B	EPA 6010B
Lead	0.65	0.24	183354	01/30/12	01/31/12	EPA 3050B	EPA 6010B
Mercury	ND	0.018	183290	01/27/12	01/27/12	METHOD	EPA 7471A
Molybdenum	0.29	0.24	183354	01/30/12	01/30/12	EPA 3050B	EPA 6010B
Nickel	23	0.24	183354	01/30/12	01/30/12	EPA 3050B	EPA 6010B
Selenium	ND	0.49	183354	01/30/12	01/30/12	EPA 3050B	EPA 6010B
Silver	ND	0.24	183354	01/30/12	01/30/12	EPA 3050B	EPA 6010B
Thallium	ND	0.49	183354	01/30/12	01/30/12	EPA 3050B	EPA 6010B
Vanadium	20	0.24	183354	01/30/12	01/30/12	EPA 3050B	EPA 6010B
Zinc	23	0.97	183354	01/30/12	01/30/12	EPA 3050B	EPA 6010B

ND= Not Detected
RL= Reporting Limit

California Title 22 Metals

Lab #:	234035	Project#:	115400
Client:	GEI Consultants, Inc.	Location:	Lower Llagas Creek
Field ID:	B-127+00W (1,2)	Basis:	as received
Lab ID:	234035-004	Diln Fac:	1.000
Matrix:	Soil	Sampled:	01/26/12
Units:	mg/Kg	Received:	01/26/12

Analyte	Result	RL	Batch#	Prepared	Analyzed	Prep	Analysis
Antimony	ND	0.53	183354	01/30/12	01/30/12	EPA 3050B	EPA 6010B
Arsenic	2.8	0.27	183354	01/30/12	01/30/12	EPA 3050B	EPA 6010B
Barium	98	0.27	183354	01/30/12	01/30/12	EPA 3050B	EPA 6010B
Beryllium	0.31	0.11	183354	01/30/12	01/30/12	EPA 3050B	EPA 6010B
Cadmium	ND	0.27	183354	01/30/12	01/30/12	EPA 3050B	EPA 6010B
Chromium	62	0.27	183354	01/30/12	01/30/12	EPA 3050B	EPA 6010B
Cobalt	11	0.27	183354	01/30/12	01/30/12	EPA 3050B	EPA 6010B
Copper	24	0.27	183354	01/30/12	01/30/12	EPA 3050B	EPA 6010B
Lead	4.0	0.27	183354	01/30/12	01/31/12	EPA 3050B	EPA 6010B
Mercury	0.035	0.018	183290	01/27/12	01/27/12	METHOD	EPA 7471A
Molybdenum	0.42	0.27	183354	01/30/12	01/30/12	EPA 3050B	EPA 6010B
Nickel	69	0.27	183354	01/30/12	01/30/12	EPA 3050B	EPA 6010B
Selenium	ND	0.53	183354	01/30/12	01/30/12	EPA 3050B	EPA 6010B
Silver	0.48	0.27	183354	01/30/12	01/30/12	EPA 3050B	EPA 6010B
Thallium	ND	0.53	183354	01/30/12	01/30/12	EPA 3050B	EPA 6010B
Vanadium	55	0.27	183354	01/30/12	01/30/12	EPA 3050B	EPA 6010B
Zinc	43	1.1	183354	01/30/12	01/30/12	EPA 3050B	EPA 6010B

ND= Not Detected

RL= Reporting Limit

California Title 22 Metals

Lab #:	234035	Project#:	115400
Client:	GEI Consultants, Inc.	Location:	Lower Llagas Creek
Field ID:	B-141+00W (1,2)	Basis:	as received
Lab ID:	234035-005	Diln Fac:	1.000
Matrix:	Soil	Sampled:	01/26/12
Units:	mg/Kg	Received:	01/26/12

Analyte	Result	RL	Batch#	Prepared	Analyzed	Prep	Analysis
Antimony	ND	0.47	183354	01/30/12	01/30/12	EPA 3050B	EPA 6010B
Arsenic	2.6	0.24	183354	01/30/12	01/30/12	EPA 3050B	EPA 6010B
Barium	110	0.24	183354	01/30/12	01/30/12	EPA 3050B	EPA 6010B
Beryllium	0.34	0.094	183354	01/30/12	01/30/12	EPA 3050B	EPA 6010B
Cadmium	ND	0.24	183354	01/30/12	01/30/12	EPA 3050B	EPA 6010B
Chromium	78	0.24	183354	01/30/12	01/30/12	EPA 3050B	EPA 6010B
Cobalt	11	0.24	183354	01/30/12	01/30/12	EPA 3050B	EPA 6010B
Copper	30	0.24	183354	01/30/12	01/30/12	EPA 3050B	EPA 6010B
Lead	2.5	0.24	183354	01/30/12	01/31/12	EPA 3050B	EPA 6010B
Mercury	0.054	0.018	183290	01/27/12	01/27/12	METHOD	EPA 7471A
Molybdenum	ND	0.24	183354	01/30/12	01/30/12	EPA 3050B	EPA 6010B
Nickel	70	0.24	183354	01/30/12	01/30/12	EPA 3050B	EPA 6010B
Selenium	ND	0.47	183354	01/30/12	01/30/12	EPA 3050B	EPA 6010B
Silver	0.61	0.24	183354	01/30/12	01/30/12	EPA 3050B	EPA 6010B
Thallium	ND	0.47	183354	01/30/12	01/30/12	EPA 3050B	EPA 6010B
Vanadium	78	0.24	183354	01/30/12	01/30/12	EPA 3050B	EPA 6010B
Zinc	49	0.94	183354	01/30/12	01/30/12	EPA 3050B	EPA 6010B

ND= Not Detected
RL= Reporting Limit

California Title 22 Metals

Lab #:	234035	Project#:	115400
Client:	GEI Consultants, Inc.	Location:	Lower Llagas Creek
Field ID:	B-166+50E (1,2)	Basis:	as received
Lab ID:	234035-006	Diln Fac:	1.000
Matrix:	Soil	Sampled:	01/26/12
Units:	mg/Kg	Received:	01/26/12

Analyte	Result	RL	Batch#	Prepared	Analyzed	Prep	Analysis
Antimony	ND	0.56	183354	01/30/12	01/30/12	EPA 3050B	EPA 6010B
Arsenic	1.7	0.28	183354	01/30/12	01/30/12	EPA 3050B	EPA 6010B
Barium	140	0.28	183354	01/30/12	01/30/12	EPA 3050B	EPA 6010B
Beryllium	0.36	0.11	183354	01/30/12	01/30/12	EPA 3050B	EPA 6010B
Cadmium	ND	0.28	183354	01/30/12	01/30/12	EPA 3050B	EPA 6010B
Chromium	110	0.28	183354	01/30/12	01/30/12	EPA 3050B	EPA 6010B
Cobalt	17	0.28	183354	01/30/12	01/30/12	EPA 3050B	EPA 6010B
Copper	31	0.28	183354	01/30/12	01/30/12	EPA 3050B	EPA 6010B
Lead	2.7	0.28	183354	01/30/12	01/31/12	EPA 3050B	EPA 6010B
Mercury	0.068	0.017	183290	01/27/12	01/27/12	METHOD	EPA 7471A
Molybdenum	ND	0.28	183354	01/30/12	01/30/12	EPA 3050B	EPA 6010B
Nickel	120	0.28	183354	01/30/12	01/30/12	EPA 3050B	EPA 6010B
Selenium	ND	0.56	183354	01/30/12	01/30/12	EPA 3050B	EPA 6010B
Silver	0.74	0.28	183354	01/30/12	01/30/12	EPA 3050B	EPA 6010B
Thallium	ND	0.56	183354	01/30/12	01/30/12	EPA 3050B	EPA 6010B
Vanadium	83	0.28	183354	01/30/12	01/30/12	EPA 3050B	EPA 6010B
Zinc	47	1.1	183354	01/30/12	01/30/12	EPA 3050B	EPA 6010B

ND= Not Detected
RL= Reporting Limit

California Title 22 Metals

Lab #:	234035	Project#:	115400
Client:	GEI Consultants, Inc.	Location:	Lower Llagas Creek
Field ID:	B-132+00W (1,2)	Basis:	as received
Lab ID:	234035-007	Diln Fac:	1.000
Matrix:	Soil	Sampled:	01/26/12
Units:	mg/Kg	Received:	01/26/12

Analyte	Result	RL	Batch#	Prepared	Analyzed	Prep	Analysis
Antimony	ND	0.54	183354	01/30/12	01/30/12	EPA 3050B	EPA 6010B
Arsenic	3.4	0.27	183354	01/30/12	01/30/12	EPA 3050B	EPA 6010B
Barium	140	0.27	183354	01/30/12	01/30/12	EPA 3050B	EPA 6010B
Beryllium	0.44	0.11	183354	01/30/12	01/30/12	EPA 3050B	EPA 6010B
Cadmium	ND	0.27	183354	01/30/12	01/30/12	EPA 3050B	EPA 6010B
Chromium	120	0.27	183354	01/30/12	01/30/12	EPA 3050B	EPA 6010B
Cobalt	20	0.27	183354	01/30/12	01/30/12	EPA 3050B	EPA 6010B
Copper	38	0.27	183354	01/30/12	01/30/12	EPA 3050B	EPA 6010B
Lead	3.5	0.27	183354	01/30/12	01/31/12	EPA 3050B	EPA 6010B
Mercury	0.063	0.018	183290	01/27/12	01/27/12	METHOD	EPA 7471A
Molybdenum	ND	0.27	183354	01/30/12	01/30/12	EPA 3050B	EPA 6010B
Nickel	140	0.27	183354	01/30/12	01/30/12	EPA 3050B	EPA 6010B
Selenium	ND	0.54	183354	01/30/12	01/30/12	EPA 3050B	EPA 6010B
Silver	0.73	0.27	183354	01/30/12	01/30/12	EPA 3050B	EPA 6010B
Thallium	ND	0.54	183354	01/30/12	01/30/12	EPA 3050B	EPA 6010B
Vanadium	90	0.27	183354	01/30/12	01/30/12	EPA 3050B	EPA 6010B
Zinc	54	1.1	183354	01/30/12	01/30/12	EPA 3050B	EPA 6010B

ND= Not Detected
RL= Reporting Limit

California Title 22 Metals

Lab #:	234035	Project#:	115400
Client:	GEI Consultants, Inc.	Location:	Lower Llagas Creek
Field ID:	B-173+50W (1,2)	Basis:	as received
Lab ID:	234035-008	Diln Fac:	1.000
Matrix:	Soil	Sampled:	01/26/12
Units:	mg/Kg	Received:	01/26/12

Analyte	Result	RL	Batch#	Prepared	Analyzed	Prep	Analysis
Antimony	ND	0.53	183354	01/30/12	01/30/12	EPA 3050B	EPA 6010B
Arsenic	2.9	0.26	183354	01/30/12	01/31/12	EPA 3050B	EPA 6010B
Barium	150	0.26	183354	01/30/12	01/30/12	EPA 3050B	EPA 6010B
Beryllium	0.44	0.11	183354	01/30/12	01/30/12	EPA 3050B	EPA 6010B
Cadmium	ND	0.26	183354	01/30/12	01/30/12	EPA 3050B	EPA 6010B
Chromium	96	0.26	183354	01/30/12	01/30/12	EPA 3050B	EPA 6010B
Cobalt	17	0.26	183354	01/30/12	01/30/12	EPA 3050B	EPA 6010B
Copper	33	0.26	183354	01/30/12	01/30/12	EPA 3050B	EPA 6010B
Lead	2.9	0.26	183354	01/30/12	01/31/12	EPA 3050B	EPA 6010B
Mercury	0.056	0.018	183290	01/27/12	01/27/12	METHOD	EPA 7471A
Molybdenum	ND	0.26	183354	01/30/12	01/30/12	EPA 3050B	EPA 6010B
Nickel	99	0.26	183354	01/30/12	01/30/12	EPA 3050B	EPA 6010B
Selenium	ND	0.53	183354	01/30/12	01/30/12	EPA 3050B	EPA 6010B
Silver	0.60	0.26	183354	01/30/12	01/30/12	EPA 3050B	EPA 6010B
Thallium	ND	0.53	183354	01/30/12	01/30/12	EPA 3050B	EPA 6010B
Vanadium	80	0.26	183354	01/30/12	01/30/12	EPA 3050B	EPA 6010B
Zinc	48	1.1	183354	01/30/12	01/30/12	EPA 3050B	EPA 6010B

ND= Not Detected
RL= Reporting Limit

California Title 22 Metals

Lab #:	234035	Project#:	115400
Client:	GEI Consultants, Inc.	Location:	Lower Llagas Creek
Field ID:	B-107+00W (1,2,3)	Basis:	as received
Lab ID:	234035-009	Diln Fac:	1.000
Matrix:	Soil	Sampled:	01/26/12
Units:	mg/Kg	Received:	01/26/12

Analyte	Result	RL	Batch#	Prepared	Analyzed	Prep	Analysis
Antimony	ND	0.45	183354	01/30/12	01/31/12	EPA 3050B	EPA 6010B
Arsenic	3.9	0.23	183354	01/30/12	01/30/12	EPA 3050B	EPA 6010B
Barium	120	0.23	183354	01/30/12	01/30/12	EPA 3050B	EPA 6010B
Beryllium	0.35	0.091	183354	01/30/12	01/30/12	EPA 3050B	EPA 6010B
Cadmium	ND	0.23	183354	01/30/12	01/30/12	EPA 3050B	EPA 6010B
Chromium	67	0.23	183354	01/30/12	01/30/12	EPA 3050B	EPA 6010B
Cobalt	11	0.23	183354	01/30/12	01/30/12	EPA 3050B	EPA 6010B
Copper	25	0.23	183354	01/30/12	01/30/12	EPA 3050B	EPA 6010B
Lead	4.5	0.23	183354	01/30/12	01/31/12	EPA 3050B	EPA 6010B
Mercury	0.042	0.018	183290	01/27/12	01/27/12	METHOD	EPA 7471A
Molybdenum	0.36	0.23	183354	01/30/12	01/30/12	EPA 3050B	EPA 6010B
Nickel	76	0.23	183354	01/30/12	01/30/12	EPA 3050B	EPA 6010B
Selenium	ND	0.45	183354	01/30/12	01/30/12	EPA 3050B	EPA 6010B
Silver	0.45	0.23	183354	01/30/12	01/30/12	EPA 3050B	EPA 6010B
Thallium	ND	0.45	183354	01/30/12	01/30/12	EPA 3050B	EPA 6010B
Vanadium	46	0.23	183354	01/30/12	01/30/12	EPA 3050B	EPA 6010B
Zinc	43	0.91	183354	01/30/12	01/30/12	EPA 3050B	EPA 6010B

ND= Not Detected
RL= Reporting Limit

California Title 22 Metals

Lab #:	234035	Project#:	115400
Client:	GEI Consultants, Inc.	Location:	Lower Llagas Creek
Field ID:	B-92+50E (1,2,3)	Basis:	as received
Lab ID:	234035-010	Diln Fac:	1.000
Matrix:	Soil	Sampled:	01/26/12
Units:	mg/Kg	Received:	01/26/12

Analyte	Result	RL	Batch#	Prepared	Analyzed	Prep	Analysis
Antimony	ND	0.49	183354	01/30/12	01/30/12	EPA 3050B	EPA 6010B
Arsenic	2.1	0.25	183354	01/30/12	01/30/12	EPA 3050B	EPA 6010B
Barium	40	0.25	183354	01/30/12	01/30/12	EPA 3050B	EPA 6010B
Beryllium	0.15	0.098	183354	01/30/12	01/30/12	EPA 3050B	EPA 6010B
Cadmium	ND	0.25	183354	01/30/12	01/30/12	EPA 3050B	EPA 6010B
Chromium	25	0.25	183354	01/30/12	01/30/12	EPA 3050B	EPA 6010B
Cobalt	3.4	0.25	183354	01/30/12	01/30/12	EPA 3050B	EPA 6010B
Copper	7.8	0.25	183354	01/30/12	01/30/12	EPA 3050B	EPA 6010B
Lead	0.74	0.25	183354	01/30/12	01/31/12	EPA 3050B	EPA 6010B
Mercury	0.061	0.018	183290	01/27/12	01/27/12	METHOD	EPA 7471A
Molybdenum	ND	0.25	183354	01/30/12	01/30/12	EPA 3050B	EPA 6010B
Nickel	21	0.25	183354	01/30/12	01/30/12	EPA 3050B	EPA 6010B
Selenium	ND	0.49	183354	01/30/12	01/30/12	EPA 3050B	EPA 6010B
Silver	ND	0.25	183354	01/30/12	01/30/12	EPA 3050B	EPA 6010B
Thallium	ND	0.49	183354	01/30/12	01/30/12	EPA 3050B	EPA 6010B
Vanadium	19	0.25	183354	01/30/12	01/30/12	EPA 3050B	EPA 6010B
Zinc	21	0.98	183354	01/30/12	01/30/12	EPA 3050B	EPA 6010B

ND= Not Detected
RL= Reporting Limit

California Title 22 Metals

Lab #:	234035	Project#:	115400
Client:	GEI Consultants, Inc.	Location:	Lower Llagas Creek
Field ID:	B-116+50E (1,2,3)	Basis:	as received
Lab ID:	234035-011	Diln Fac:	1.000
Matrix:	Soil	Sampled:	01/26/12
Units:	mg/Kg	Received:	01/26/12

Analyte	Result	RL	Batch#	Prepared	Analyzed	Prep	Analysis
Antimony	1.1	0.52	183354	01/30/12	01/31/12	EPA 3050B	EPA 6010B
Arsenic	5.9	0.26	183354	01/30/12	01/31/12	EPA 3050B	EPA 6010B
Barium	140	0.26	183354	01/30/12	01/31/12	EPA 3050B	EPA 6010B
Beryllium	0.42	0.10	183354	01/30/12	01/31/12	EPA 3050B	EPA 6010B
Cadmium	ND	0.26	183354	01/30/12	01/31/12	EPA 3050B	EPA 6010B
Chromium	54	0.26	183354	01/30/12	01/31/12	EPA 3050B	EPA 6010B
Cobalt	12	0.26	183354	01/30/12	01/31/12	EPA 3050B	EPA 6010B
Copper	27	0.26	183354	01/30/12	01/31/12	EPA 3050B	EPA 6010B
Lead	5.7	0.26	183354	01/30/12	01/31/12	EPA 3050B	EPA 6010B
Mercury	0.045	0.017	183290	01/27/12	01/27/12	METHOD	EPA 7471A
Molybdenum	ND	0.26	183354	01/30/12	01/31/12	EPA 3050B	EPA 6010B
Nickel	78	0.26	183354	01/30/12	01/31/12	EPA 3050B	EPA 6010B
Selenium	ND	0.52	183354	01/30/12	01/31/12	EPA 3050B	EPA 6010B
Silver	0.39	0.26	183354	01/30/12	01/31/12	EPA 3050B	EPA 6010B
Thallium	ND	0.52	183354	01/30/12	01/31/12	EPA 3050B	EPA 6010B
Vanadium	43	0.26	183354	01/30/12	01/31/12	EPA 3050B	EPA 6010B
Zinc	53	1.0	183354	01/30/12	01/31/12	EPA 3050B	EPA 6010B

ND= Not Detected
RL= Reporting Limit

California Title 22 Metals

Lab #:	234035	Project#:	115400
Client:	GEI Consultants, Inc.	Location:	Lower Llagas Creek
Field ID:	B-92+50W (1,2)	Basis:	as received
Lab ID:	234035-012	Diln Fac:	1.000
Matrix:	Soil	Sampled:	01/26/12
Units:	mg/Kg	Received:	01/26/12

Analyte	Result	RL	Batch#	Prepared	Analyzed	Prep	Analysis
Antimony	ND	0.46	183354	01/30/12	01/31/12	EPA 3050B	EPA 6010B
Arsenic	5.0	0.23	183354	01/30/12	01/31/12	EPA 3050B	EPA 6010B
Barium	150	0.23	183354	01/30/12	01/31/12	EPA 3050B	EPA 6010B
Beryllium	0.38	0.093	183354	01/30/12	01/31/12	EPA 3050B	EPA 6010B
Cadmium	ND	0.23	183354	01/30/12	01/31/12	EPA 3050B	EPA 6010B
Chromium	60	0.23	183354	01/30/12	01/31/12	EPA 3050B	EPA 6010B
Cobalt	12	0.23	183354	01/30/12	01/31/12	EPA 3050B	EPA 6010B
Copper	29	0.23	183354	01/30/12	01/31/12	EPA 3050B	EPA 6010B
Lead	10	0.23	183354	01/30/12	01/31/12	EPA 3050B	EPA 6010B
Mercury	0.071	0.017	183290	01/27/12	01/27/12	METHOD	EPA 7471A
Molybdenum	ND	0.23	183354	01/30/12	01/31/12	EPA 3050B	EPA 6010B
Nickel	75	0.23	183354	01/30/12	01/31/12	EPA 3050B	EPA 6010B
Selenium	ND	0.46	183354	01/30/12	01/31/12	EPA 3050B	EPA 6010B
Silver	0.47	0.23	183354	01/30/12	01/31/12	EPA 3050B	EPA 6010B
Thallium	ND	0.46	183354	01/30/12	01/31/12	EPA 3050B	EPA 6010B
Vanadium	56	0.23	183354	01/30/12	01/31/12	EPA 3050B	EPA 6010B
Zinc	53	0.93	183354	01/30/12	01/31/12	EPA 3050B	EPA 6010B

ND= Not Detected
RL= Reporting Limit

California Title 22 Metals

Lab #:	234035	Project#:	115400
Client:	GEI Consultants, Inc.	Location:	Lower Llagas Creek
Field ID:	B-78+00W (1,2)	Basis:	as received
Lab ID:	234035-013	Diln Fac:	1.000
Matrix:	Soil	Sampled:	01/26/12
Units:	mg/Kg	Received:	01/26/12

Analyte	Result	RL	Batch#	Prepared	Analyzed	Prep	Analysis
Antimony	ND	0.50	183354	01/30/12	01/31/12	EPA 3050B	EPA 6010B
Arsenic	3.3	0.25	183354	01/30/12	01/31/12	EPA 3050B	EPA 6010B
Barium	160	0.25	183354	01/30/12	01/31/12	EPA 3050B	EPA 6010B
Beryllium	0.40	0.10	183354	01/30/12	01/31/12	EPA 3050B	EPA 6010B
Cadmium	ND	0.25	183354	01/30/12	01/31/12	EPA 3050B	EPA 6010B
Chromium	110	0.25	183354	01/30/12	01/31/12	EPA 3050B	EPA 6010B
Cobalt	15	0.25	183354	01/30/12	01/31/12	EPA 3050B	EPA 6010B
Copper	31	0.25	183354	01/30/12	01/31/12	EPA 3050B	EPA 6010B
Lead	4.9	0.25	183354	01/30/12	01/31/12	EPA 3050B	EPA 6010B
Mercury	0.054	0.018	183290	01/27/12	01/27/12	METHOD	EPA 7471A
Molybdenum	ND	0.25	183354	01/30/12	01/31/12	EPA 3050B	EPA 6010B
Nickel	110	0.25	183354	01/30/12	01/31/12	EPA 3050B	EPA 6010B
Selenium	ND	0.50	183354	01/30/12	01/31/12	EPA 3050B	EPA 6010B
Silver	0.66	0.25	183354	01/30/12	01/31/12	EPA 3050B	EPA 6010B
Thallium	ND	0.50	183354	01/30/12	01/31/12	EPA 3050B	EPA 6010B
Vanadium	83	0.25	183354	01/30/12	01/31/12	EPA 3050B	EPA 6010B
Zinc	53	1.0	183354	01/30/12	01/31/12	EPA 3050B	EPA 6010B

ND= Not Detected
RL= Reporting Limit

California Title 22 Metals

Lab #:	234035	Project#:	115400
Client:	GEI Consultants, Inc.	Location:	Lower Llagas Creek
Field ID:	B-132+50E (1,2)	Basis:	as received
Lab ID:	234035-014	Diln Fac:	1.000
Matrix:	Soil	Sampled:	01/26/12
Units:	mg/Kg	Received:	01/26/12

Analyte	Result	RL	Batch#	Prepared	Analyzed	Prep	Analysis
Antimony	ND	0.47	183354	01/30/12	01/31/12	EPA 3050B	EPA 6010B
Arsenic	2.7	0.24	183354	01/30/12	01/31/12	EPA 3050B	EPA 6010B
Barium	33	0.24	183354	01/30/12	01/31/12	EPA 3050B	EPA 6010B
Beryllium	0.14	0.094	183354	01/30/12	01/31/12	EPA 3050B	EPA 6010B
Cadmium	ND	0.24	183354	01/30/12	01/31/12	EPA 3050B	EPA 6010B
Chromium	8.5	0.24	183354	01/30/12	01/31/12	EPA 3050B	EPA 6010B
Cobalt	1.5	0.24	183354	01/30/12	01/31/12	EPA 3050B	EPA 6010B
Copper	4.7	0.24	183354	01/30/12	01/31/12	EPA 3050B	EPA 6010B
Lead	0.50	0.24	183354	01/30/12	01/31/12	EPA 3050B	EPA 6010B
Mercury	ND	0.018	183290	01/27/12	01/27/12	METHOD	EPA 7471A
Molybdenum	ND	0.24	183354	01/30/12	01/31/12	EPA 3050B	EPA 6010B
Nickel	6.1	0.24	183354	01/30/12	01/31/12	EPA 3050B	EPA 6010B
Selenium	ND	0.47	183354	01/30/12	01/31/12	EPA 3050B	EPA 6010B
Silver	ND	0.24	183354	01/30/12	01/31/12	EPA 3050B	EPA 6010B
Thallium	ND	0.47	183354	01/30/12	01/31/12	EPA 3050B	EPA 6010B
Vanadium	9.6	0.24	183354	01/30/12	01/31/12	EPA 3050B	EPA 6010B
Zinc	26	0.94	183354	01/30/12	01/31/12	EPA 3050B	EPA 6010B

ND= Not Detected
RL= Reporting Limit

California Title 22 Metals

Lab #:	234035	Project#:	115400
Client:	GEI Consultants, Inc.	Location:	Lower Llagas Creek
Field ID:	B-148+00E (1,2)	Basis:	as received
Lab ID:	234035-015	Diln Fac:	1.000
Matrix:	Soil	Sampled:	01/26/12
Units:	mg/Kg	Received:	01/26/12

Analyte	Result	RL	Batch#	Prepared	Analyzed	Prep	Analysis
Antimony	ND	0.51	183354	01/30/12	01/31/12	EPA 3050B	EPA 6010B
Arsenic	3.8	0.26	183354	01/30/12	01/31/12	EPA 3050B	EPA 6010B
Barium	130	0.26	183354	01/30/12	01/31/12	EPA 3050B	EPA 6010B
Beryllium	0.39	0.10	183354	01/30/12	01/31/12	EPA 3050B	EPA 6010B
Cadmium	ND	0.26	183354	01/30/12	01/31/12	EPA 3050B	EPA 6010B
Chromium	78	0.26	183354	01/30/12	01/31/12	EPA 3050B	EPA 6010B
Cobalt	14	0.26	183354	01/30/12	01/31/12	EPA 3050B	EPA 6010B
Copper	43	0.26	183354	01/30/12	01/31/12	EPA 3050B	EPA 6010B
Lead	6.0	0.26	183354	01/30/12	01/31/12	EPA 3050B	EPA 6010B
Mercury	0.058	0.018	183290	01/27/12	01/27/12	METHOD	EPA 7471A
Molybdenum	ND	0.26	183354	01/30/12	01/31/12	EPA 3050B	EPA 6010B
Nickel	93	0.26	183354	01/30/12	01/31/12	EPA 3050B	EPA 6010B
Selenium	ND	0.51	183354	01/30/12	01/31/12	EPA 3050B	EPA 6010B
Silver	0.55	0.26	183354	01/30/12	01/31/12	EPA 3050B	EPA 6010B
Thallium	ND	0.51	183354	01/30/12	01/31/12	EPA 3050B	EPA 6010B
Vanadium	70	0.26	183354	01/30/12	01/31/12	EPA 3050B	EPA 6010B
Zinc	48	1.0	183354	01/30/12	01/31/12	EPA 3050B	EPA 6010B

ND= Not Detected
RL= Reporting Limit

Batch QC Report

California Title 22 Metals

Lab #:	234035	Location:	Lower Llagas Creek
Client:	GEI Consultants, Inc.	Prep:	METHOD
Project#:	115400	Analysis:	EPA 7471A
Analyte:	Mercury	Diln Fac:	1.000
Type:	BLANK	Batch#:	183290
Lab ID:	QC626709	Prepared:	01/27/12
Matrix:	Soil	Analyzed:	01/27/12
Units:	mg/Kg		

Result	RL
ND	0.017

ND= Not Detected
RL= Reporting Limit

Batch QC Report

California Title 22 Metals

Lab #:	234035	Location:	Lower Llagas Creek
Client:	GEI Consultants, Inc.	Prep:	METHOD
Project#:	115400	Analysis:	EPA 7471A
Analyte:	Mercury	Batch#:	183290
Matrix:	Soil	Prepared:	01/27/12
Units:	mg/Kg	Analyzed:	01/27/12
Diln Fac:	1.000		

Type	Lab ID	Spiked	Result	%REC	Limits	RPD	Lim
BS	QC626710	0.2083	0.2254	108	80-121		
BSD	QC626711	0.2083	0.2268	109	80-121	1	31

RPD= Relative Percent Difference

Batch QC Report

California Title 22 Metals

Lab #:	234035	Location:	Lower Llagas Creek
Client:	GEI Consultants, Inc.	Prep:	METHOD
Project#:	115400	Analysis:	EPA 7471A
Analyte:	Mercury	Diln Fac:	1.000
Field ID:	ZZZZZZZZZZ	Batch#:	183290
MSS Lab ID:	234014-001	Sampled:	01/25/12
Matrix:	Soil	Received:	01/25/12
Units:	mg/Kg	Prepared:	01/27/12
Basis:	as received	Analyzed:	01/27/12

Type	Lab ID	MSS Result	Spiked	Result	%REC	Limits	RPD	Lim
MS	QC626712	0.08404	0.2232	0.3375	114	65-142		
MSD	QC626713		0.2273	0.3286	108	65-142	4	35

RPD= Relative Percent Difference

Batch QC Report

California Title 22 Metals

Lab #:	234035	Location:	Lower Llagas Creek
Client:	GEI Consultants, Inc.	Prep:	EPA 3050B
Project#:	115400	Analysis:	EPA 6010B
Type:	BLANK	Diln Fac:	1.000
Lab ID:	QC626969	Batch#:	183354
Matrix:	Soil	Prepared:	01/30/12
Units:	mg/Kg	Analyzed:	01/30/12

Analyte	Result	RL
Antimony	ND	0.50
Arsenic	ND	0.25
Barium	ND	0.25
Beryllium	ND	0.10
Cadmium	ND	0.25
Chromium	ND	0.25
Cobalt	ND	0.25
Copper	ND	0.25
Lead	ND	0.25
Molybdenum	ND	0.25
Nickel	ND	0.25
Selenium	ND	0.50
Silver	ND	0.25
Thallium	ND	0.50
Vanadium	ND	0.25
Zinc	ND	1.0

ND= Not Detected
RL= Reporting Limit

Batch QC Report

California Title 22 Metals

Lab #:	234035	Location:	Lower Llagas Creek
Client:	GEI Consultants, Inc.	Prep:	EPA 3050B
Project#:	115400	Analysis:	EPA 6010B
Matrix:	Soil	Batch#:	183354
Units:	mg/Kg	Prepared:	01/30/12
Diln Fac:	1.000		

Type: BS Lab ID: QC626970

Analyte	Spiked	Result	%REC	Limits	Analyzed
Antimony	100.0	97.49	97	80-120	01/30/12
Arsenic	50.00	53.87	108	80-121	01/30/12
Barium	100.0	101.5	102	80-120	01/30/12
Beryllium	2.500	2.645	106	80-120	01/30/12
Cadmium	10.00	10.54	105	80-120	01/30/12
Chromium	100.0	101.0	101	80-120	01/30/12
Cobalt	25.00	24.27	97	80-120	01/30/12
Copper	12.50	12.14	97	80-120	01/30/12
Lead	100.0	91.19	91	80-120	01/31/12
Molybdenum	20.00	19.80	99	80-120	01/30/12
Nickel	25.00	24.69	99	80-120	01/30/12
Selenium	50.00	48.86	98	80-120	01/30/12
Silver	10.00	10.22	102	80-120	01/30/12
Thallium	50.00	50.76	102	80-120	01/30/12
Vanadium	25.00	25.46	102	80-120	01/30/12
Zinc	25.00	25.07	100	80-120	01/30/12

Type: BSD Lab ID: QC626971

Analyte	Spiked	Result	%REC	Limits	RPD	Lim	Analyzed
Antimony	100.0	102.0	102	80-120	4	20	01/30/12
Arsenic	50.00	55.86	112	80-121	4	20	01/30/12
Barium	100.0	104.3	104	80-120	3	20	01/30/12
Beryllium	2.500	2.718	109	80-120	3	20	01/30/12
Cadmium	10.00	10.87	109	80-120	3	20	01/30/12
Chromium	100.0	103.8	104	80-120	3	20	01/30/12
Cobalt	25.00	25.08	100	80-120	3	20	01/30/12
Copper	12.50	12.53	100	80-120	3	20	01/30/12
Lead	100.0	93.82	94	80-120	3	20	01/31/12
Molybdenum	20.00	20.49	102	80-120	3	20	01/30/12
Nickel	25.00	25.54	102	80-120	3	20	01/30/12
Selenium	50.00	50.87	102	80-120	4	20	01/30/12
Silver	10.00	10.61	106	80-120	4	20	01/30/12
Thallium	50.00	52.51	105	80-120	3	20	01/30/12
Vanadium	25.00	26.22	105	80-120	3	20	01/30/12
Zinc	25.00	25.68	103	80-120	2	20	01/30/12

RPD= Relative Percent Difference

Batch QC Report

California Title 22 Metals

Lab #:	234035	Location:	Lower Llagas Creek
Client:	GEI Consultants, Inc.	Prep:	EPA 3050B
Project#:	115400	Analysis:	EPA 6010B
Field ID:	ZZZZZZZZZZ	Diln Fac:	1.000
MSS Lab ID:	234051-002	Batch#:	183354
Matrix:	Soil	Sampled:	01/27/12
Units:	mg/Kg	Received:	01/27/12
Basis:	as received	Prepared:	01/30/12

Type: MS   Lab ID: QC626972

Analyte	MSS Result	Spiked	Result	%REC	Limits	Analyzed
Antimony	0.6897	101.0	37.11	36	11-120	01/30/12
Arsenic	3.697	50.51	55.21	102	71-123	01/30/12
Barium	94.95	101.0	185.5	90	48-139	01/30/12
Beryllium	0.3099	2.525	2.899	103	77-120	01/30/12
Cadmium	0.4100	10.10	10.04	95	72-120	01/30/12
Chromium	13.40	101.0	110.7	96	60-125	01/30/12
Cobalt	5.787	25.25	27.93	88	57-124	01/30/12
Copper	13.48	12.63	25.03	91	46-155	01/30/12
Lead	2.920	101.0	85.20	81	57-126	01/31/12
Molybdenum	1.975	20.20	19.11	85	68-120	01/30/12
Nickel	17.03	25.25	40.47	93	45-139	01/30/12
Selenium	<0.1536	50.51	47.70	94	68-120	01/30/12
Silver	0.2305	10.10	10.69	104	72-120	01/30/12
Thallium	0.7446	50.51	45.75	89	66-120	01/30/12
Vanadium	29.46	25.25	50.43	83	51-142	01/30/12
Zinc	37.35	25.25	66.61	116	41-148	01/30/12

Type: MSD   Lab ID: QC626973

Analyte	Spiked	Result	%REC	Limits	RPD	Lim	Analyzed
Antimony	98.04	35.51	36	11-120	1	36	01/30/12
Arsenic	49.02	53.20	101	71-123	1	38	01/30/12
Barium	98.04	176.6	83	48-139	3	46	01/30/12
Beryllium	2.451	2.805	102	77-120	1	22	01/30/12
Cadmium	9.804	9.766	95	72-120	0	30	01/30/12
Chromium	98.04	108.1	97	60-125	0	34	01/30/12
Cobalt	24.51	27.09	87	57-124	1	36	01/30/12
Copper	12.25	27.70	116	46-155	12	37	01/30/12
Lead	98.04	84.35	83	57-126	2	43	01/31/12
Molybdenum	19.61	18.97	87	68-120	2	24	01/30/12
Nickel	24.51	38.49	88	45-139	3	37	01/30/12
Selenium	49.02	45.90	94	68-120	1	28	01/30/12
Silver	9.804	10.44	104	72-120	1	31	01/30/12
Thallium	49.02	44.53	89	66-120	0	22	01/30/12
Vanadium	24.51	54.58	102	51-142	9	32	01/30/12
Zinc	24.51	57.68	83	41-148	13	38	01/30/12

RPD= Relative Percent Difference

Curtis & Tompkins, Ltd.
Analytical Laboratories, Since 1878

Curtis & Tompkins, Ltd., Analytical Laboratories, Since 1878
2323 Fifth Street, Berkeley, CA 94710, Phone (510) 486-0900

Laboratory Job Number 235268
ANALYTICAL REPORT

GEI Consultants, Inc.
180 Grand Avenue
Oakland, CA 94612

Project : 115400
Location : Lower Llagas Creek
Level : II

Sample ID	Lab ID
B-50+00W (1,2)	235268-001
B-59+00W (1,2)	235268-002
B-166+50E (1,2)	235268-003
B-141+00W (1,2)	235268-004
B-127+00W (1,2)	235268-005
B-173+50W (1,2)	235268-006
B-132+00W (1,2)	235268-007
B-116+50E (1,2,3)	235268-008
B-107+00W (1,2,3)	235268-009
B-92+50W (1,2)	235268-010
B-78+00W (1,2)	235268-011
B-148+00E (1,2)	235268-012

This data package has been reviewed for technical correctness and completeness. Release of this data has been authorized by the Laboratory Manager or the Manager's designee, as verified by the following signature. The results contained in this report meet all requirements of NELAC and pertain only to those samples which were submitted for analysis. This report may be reproduced only in its entirety.

Signature: Denise N. Tetrault
Project Manager

Date: 04/09/2012

NELAP # 01107CA

CASE NARRATIVE

Laboratory number:	**235268**
Client:	**GEI Consultants, Inc.**
Project:	**115400**
Location:	**Lower Llagas Creek**
Request Date:	**04/02/12**
Samples Received:	**04/02/12**

This data package contains sample and QC results for twelve soil samples, requested for the above referenced project on 04/02/12. The samples were received intact.

Metals (EPA 6010B):
No analytical problems were encountered.

CHAIN OF CUSTODY

Curtis & Tompkins Laboratories
ENVIRONMENTAL ANALYTICAL TESTING LABORATORY
In Business Since 1878

2323 Fifth Street
Berkeley, CA 94710

Phone (510) 486-0900
Fax (510) 486-0532

C&T LOGIN # 235268

Page 1 of 1
Chain of Custody # 1

Project No: 115400
Project Name: LOWER LLAGAS CREEK
Project P. O. No:
EDD Format: Report Level ☐ II ☐ III ☐ IV
Turnaround Time: ☐ RUSH ______ ☒ Standard

Sampler: MATT POWERS
Report To: MATT POWERS
Company: GEI CONSULTANTS
Telephone: 510-350-2902
Email: mpowers@geiconsultants.com

Lab No.	Sample ID.	SAMPLING Date Collected	SAMPLING Time Collected	MATRIX Water	MATRIX Solid	# of Containers	CHEMICAL PRESERVATIVE HCl	H2SO4	HNO3	NaOH	None	ANALYTICAL REQUEST STLC METALS (Chromium)
1	B-50+00W (1,2)	3/29/12	9:00A		X	1					X	X
2	B-59+00W (1,2)		9:05A		X	1					X	X
3	B-160+50E (1,2)		9:05A		X	1					X	X
4	B-141+00W (1,2)		9:15A		X	1					X	X
5	B-127+00W (1,2)		9:20A		X	1					X	X
6	B-173+50W (1,2)		9:35A		X	1					X	X
7	B-132+00W (1,2)		9:35A		X	1					X	X
8	B-116+50E (1,2,3)		9:45A		X	1					X	X
9	B-107+00W (1,2,3)		9:50A		X	1					X	X
10	B-92+50W (1,2)		9:55A		X	1					X	X
11	B-78+00W (1,2)		9:55A		X	1					X	X
12	B-148+00E (1,2)	↓	10:00A		X	1					X	X

Notes:

SAMPLE RECEIPT
☐ Intact
☐ Cold
☐ On Ice
☐ Ambient

RELINQUISHED BY:
DATE: 4/2/12 TIME: 11:05
DATE: TIME:
DATE: TIME:

RECEIVED BY:
DATE: 4/2/12 TIME: 1105
DATE: TIME:
DATE: TIME:

COOLER RECEIPT CHECKLIST

Curtis & Tompkins, Ltd.

Login # 235208 Date Received 4/2/12 Number of coolers 1
Client GEI CONSULTANTS Project 115400

Date Opened 4/2/12 By (print) I-CHOI (sign)
Date Logged in ↓ By (print) ↓ (sign) ↓

1. Did cooler come with a shipping slip (airbill, etc) YES [✓ NO]
Shipping info

2A. Were custody seals present? .... ☐ YES (circle) on cooler on samples ☒ NO
How many Name Date
2B. Were custody seals intact upon arrival? YES NO [✓ N/A]
3. Were custody papers dry and intact when received? [✓ YES] NO
4. Were custody papers filled out properly (ink, signed, etc)? [✓ YES] NO
5. Is the project identifiable from custody papers? (If so fill out top of form) [✓ YES] NO
6. Indicate the packing in cooler: (if other, describe)

☐ Bubble Wrap ☐ Foam blocks ☐ Bags ☐ None
☐ Cloth material ☒ Cardboard ☐ Styrofoam ☐ Paper towels

7. Temperature documentation: * Notify PM if temperature exceeds 6°C

Type of ice used: ☐ Wet ☐ Blue/Gel ☒ None Temp(°C)

☐ Samples Received on ice & cold without a temperature blank; temp. taken with IR gun

☐ Samples received on ice directly from the field. Cooling process had begun

8. Were Method 5035 sampling containers present? YES [✓ NO]
If YES, what time were they transferred to freezer?
9. Did all bottles arrive unbroken/unopened? [✓ YES] NO
10. Are there any missing / extra samples? YES [✓ NO]
11. Are samples in the appropriate containers for indicated tests? [✓ YES] NO
12. Are sample labels present, in good condition and complete? [✓ YES] NO
13. Do the sample labels agree with custody papers? [✓ YES] NO
14. Was sufficient amount of sample sent for tests requested? [✓ YES] NO
15. Are the samples appropriately preserved? YES NO [✓ N/A]
16. Did you check preservatives for all bottles for each sample? YES NO [✓ N/A]
17. Did you document your preservative check? YES NO [✓ N/A]
18. Did you change the hold time in LIMS for unpreserved VOAs? YES NO [✓ N/A]
19. Did you change the hold time in LIMS for preserved terracores? YES NO [✓ N/A]
20. Are bubbles > 6mm absent in VOA samples? YES NO [✓ N/A]
21. Was the client contacted concerning this sample delivery? YES [✓ NO]
If YES, Who was called? By Date:

COMMENTS

Chromium

Lab #:	235268	Location:	Lower Llagas Creek
Client:	GEI Consultants, Inc.	Prep:	WET
Project#:	115400	Analysis:	EPA 6010B
Analyte:	Chromium	Sampled:	03/29/12
Matrix:	WET Leachate	Received:	04/02/12
Units:	ug/L	Prepared:	04/05/12
Diln Fac:	10.00	Analyzed:	04/05/12
Batch#:	185276		

Field ID	Type	Lab ID	Result	RL
B-50+00W (1,2)	SAMPLE	235268-001	710	250
B-59+00W (1,2)	SAMPLE	235268-002	910	250
B-166+50E (1,2)	SAMPLE	235268-003	480	250
B-141+00W (1,2)	SAMPLE	235268-004	260	250
B-127+00W (1,2)	SAMPLE	235268-005	260	250
B-173+50W (1,2)	SAMPLE	235268-006	420	250
B-132+00W (1,2)	SAMPLE	235268-007	400	250
B-116+50E (1,2,3)	SAMPLE	235268-008	ND	250
B-107+00W (1,2,3)	SAMPLE	235268-009	370	250
B-92+50W (1,2)	SAMPLE	235268-010	620	250
B-78+00W (1,2)	SAMPLE	235268-011	510	250
B-148+00E (1,2)	SAMPLE	235268-012	300	250
	BLANK	QC634548	ND	250

ND= Not Detected
RL= Reporting Limit

Batch QC Report

Chromium

Lab #:	235268	Location:	Lower Llagas Creek
Client:	GEI Consultants, Inc.	Prep:	WET
Project#:	115400	Analysis:	EPA 6010B
Analyte:	Chromium	Batch#:	185276
Field ID:	B-50+00W (1,2)	Sampled:	03/29/12
MSS Lab ID:	235268-001	Received:	04/02/12
Matrix:	WET Leachate	Prepared:	04/05/12
Units:	ug/L	Analyzed:	04/05/12

Type	Lab ID	MSS Result	Spiked	Result	%REC	Limits	RPD	Lim	Diln Fac
BS	QC634549		2,000	1,879	94	80-120			1.000
BSD	QC634550		2,000	1,824	91	80-120	3	20	1.000
MS	QC634551	705.7	10,000	10,010	93	73-120			10.00
MSD	QC634552		10,000	9,995	93	73-120	0	21	10.00

RPD= Relative Percent Difference

NON-HAZARDOUS WASTE MANIFEST

1. Generator ID Number: EXEMPT

2. Page 1 of: 1

3. Emergency Response Phone: NRCES 510 749-1390

4. Waste Tracking Number: 67695-01

5. Generator's Name and Mailing Address: MATTHEW POWERS GEI CONSUTANTS
SANTA CLARA VALLEY WATER DISTRICT
5750 ALMADEN EXPRESSWAY
SAN JOSE CA 95118

Generator's Phone: 510 350-2902

Generator's Site Address (if different than mailing address):
SANTA CLARA VALLEY WATER DISTRICT
LLAGAS CREEK CHANNEL- SOUTHSIDE DR
GILROY CA

6. Transporter 1 Company Name: NRC ENVIRONMENTAL SERVICES INC.

U.S. EPA ID Number: CAR000030114

7. Transporter 2 Company Name: INTRINSIC

U.S. EPA ID Number: CAR000105274

8. Designated Facility Name and Site Address:
Crosby & Overton, Inc.
1630 W. 17th Street
Long Beach CA 90813

Facility's Phone: 562 432-5445

U.S. EPA ID Number: CAD028409019

9. Waste Shipping Name and Description	10. Containers No.	10. Containers Type	11. Total Quantity	12. Unit Wt./Vol.
1. NON-HAZARDOUS WASTE, LIQUID (DRILLING SLUDGES)	016	DM	0800	G
2.				
3.				
4.				

13. Special Handling Instructions and Additional Information
USE PROPER PERSONAL PROTECTIVE EQUIPMENT JOB/PO#:67695 PROFILE# 56881 (16X55)
GEI CONSULTANTS: 180 GRAND AVE, SUITE 1410, OAKLAND, CA. 94612
NRC ENVIRONMENTAL SERVICES, 1605 FERRY POINT, ALAMEDA, CA 94501
D64368

14. GENERATOR'S/OFFEROR'S CERTIFICATION: I hereby declare that the contents of this consignment are fully and accurately described above by the proper shipping name, and are classified, packaged, marked and labeled/placarded, and are in all respects in proper condition for transport according to applicable international and national governmental regulations.

Generator's/Offeror's Printed/Typed Name: Matthew Powers
Signature:
Month 4 Day 27 Year 12

15. International Shipments ☐ Import to U.S. ☐ Export from U.S. Port of entry/exit:
Transporter Signature (for exports only): Date leaving U.S.:

16. Transporter Acknowledgment of Receipt of Materials

Transporter 1 Printed/Typed Name: Marcial Barragán
Signature:
Month 2/ Day 27 Year 12

Transporter 2 Printed/Typed Name: Alex Bell
Signature:
Month 5 Day 3 Year 12

17. Discrepancy

17a. Discrepancy Indication Space ☐ Quantity ☐ Type ☐ Residue ☐ Partial Rejection ☐ Full Rejection

Manifest Reference Number:

THE REFERENCED WASTE WAS RECEIVED, HANDLED AND STORED FOR SUBSEQUENT OFFSITE DISPOSAL, TREATMENT OR REUSE. CROSBY & OVERTON, INC. OPERATES THE FACILITY UNDER PERMITS GRANTED TO THEM, BY THE DEPARTMENT OF TOXIC SUBSTANCE CONTROL, TOGETHER WITH THE ENVIRONMENTAL PROTECTION AGENCY IN ACCORDANCE WITH THE PROVISIONS OF THE RESOURCE CONSERVATION AND RECOVERY ACT OF 1976 TOGETHER WITH APPLICABLE FEDERAL AND STATE REGULATIONS. CROSBY & OVERTON HAS ALL OF THE NECESSARY PERMITS TO [illegible] THE REFERENCED WASTE AND ALL THE WASTE HAS BEEN HANDLED ACCORDINGLY

17b. Alternate Facility (or Generator)

U.S. EPA ID Number

Facility's Phone:

17c. Signature of Alternate Facility (or Generator)
Month Day Year

HTH

18. Designated Facility Owner or Operator: Certification of receipt of materials covered by the manifest except as noted in Item 17a

Printed/Typed Name: J Belleza
Signature: J Belleza
Month 05 Day 03 Year 12

169-BLC-O 6 10498 (Rev. 9/09)

DESIGNATED FACILITY TO GENERATOR

NON-HAZARDOUS WASTE MANIFEST

1. Generator ID Number: EXEMPT
2. Page 1 of 1
3. Emergency Response Phone: NRCES 510 749-1390
4. Waste Tracking Number: 67695-02

5. Generator's Name and Mailing Address MATTHEW POWERS GEI CONSUTANTS
SANTA CLARA VALLEY WATER DISTRICT
5750 ALMADEN EXPRESSWAY
SAN JOSE CA 95118
Generator's Phone: 510 350-2902

Generator's Site Address (if different than mailing address)
SANTA CLARA VALLEY WATER DISTRICT
LLAGAS CREEK CHANNEL- SOUTHSIDE DR
GILROY CA

6. Transporter 1 Company Name: NRC ENVIRONMENTAL SERVICES INC.
U.S. EPA ID Number: CAR000030114

7. Transporter 2 Company Name: INTRINSIC
U.S. EPA ID Number: CAR000105274

8. Designated Facility Name and Site Address
Crosby & Overton, Inc.
1630 W. 17th Street
Long Beach CA 90813
Facility's Phone: 562 432-5445
U.S. EPA ID Number: CAD028409019

9. Waste Shipping Name and Description	10. Containers No.	10. Containers Type	11. Total Quantity	12. Unit Wt./Vol.
1. NON-HAZARDOUS WASTE, LIQUID (DRILLING SLUDGES)	022	DM	1100	G
2.				
3.				
4.				

13. Special Handling Instructions and Additional Information
USE PROPER PERSONAL PROTECTIVE EQUIPMENT JOB/PO#:67695 PROFILE# 56881 22X55
GEI CONSULTANTS: 180 GRAND AVE, SUITE 1410, OAKLAND, CA. 94612
NRC ENVIRONMENTAL SERVICES, 1605 FERRY POINT, ALAMEDA, CA 94501
D64367

14. GENERATOR'S/OFFEROR'S CERTIFICATION: I hereby declare that the contents of this consignment are fully and accurately described above by the proper shipping name, and are classified, packaged, marked and labeled/placarded, and are in all respects in proper condition for transport according to applicable international and national governmental regulations.

Generator's/Offeror's Printed/Typed Name: Matthew Powers
Signature:
Month 4 Day 27 Year 12

15. International Shipments ☐ Import to U.S. ☐ Export from U.S. Port of entry/exit:
Transporter Signature (for exports only): Date leaving U.S.:

16. Transporter Acknowledgment of Receipt of Materials
Transporter 1 Printed/Typed Name: Marcial Barragán
Signature:
Month 4 Day 27 Year 12
Transporter 2 Printed/Typed Name: Alex Bell
Signature:
Month 5 Day 3 Year 12

17. Discrepancy
17a. Discrepancy Indication Space ☐ Quantity ☐ Type ☐ Residue ☐ Partial Rejection ☐ Full Rejection

THE REFERENCED WASTE WAS RECEIVED, HANDLED AND STORED FOR SUBSEQUENT OFFSITE DISPOSAL, TREATMENT OR REUSE. CROSBY & OVERTON, INC. OPERATES THE FACILITY UNDER PERMITS ISSUED TO THEM, BY THE DEPARTMENT OF TOXIC SUBSTANCE CONTROL, TOGETHER WITH THE ENVIRONMENTAL PROTECTION AGENCY IN ACCORDANCE WITH THE PROVISIONS OF THE RESOURCE CONSERVATION AND RECOVERY ACT OF 1976 TOGETHER WITH APPLICABLE FEDERAL AND STATE REGULATIONS. CROSBY & OVERTON HAS ALL OF THE NECESSARY PERMITS TO ACCEPT THE REFERENCED WASTE AND ALL THE WASTE HAS BEEN HANDLED ACCORDINGLY

Manifest Reference Number:
17b. Alternate Facility (or Generator)
U.S. EPA ID Number
Facility's Phone:
17c. Signature of Alternate Facility (or Generator) Month Day Year

H141

18. Designated Facility Owner or Operator: Certification of receipt of materials covered by the manifest except as noted in Item 17a
Printed/Typed Name: J Belleza
Signature: J Belleza
Month 05 Day 03 Year 12

169-BLC-O 6 10498 (Rev. 9/09)

DESIGNATED FACILITY TO GENERATOR

Appendix D

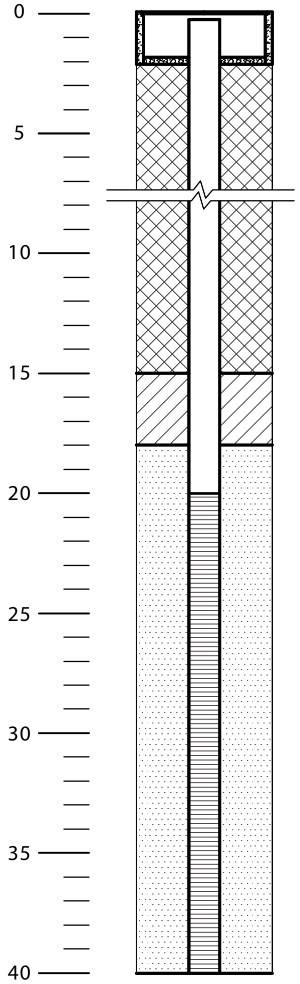
Stand-Pipe Piezometer Well Completion Details

PACIFIC GEOTECHNICAL ENGINEERING
MONITORING WELL COMPLETION SUMMARY

WELL NO.: P-132 + 50E
PAGE: 1 OF 1

JOB NO.: 2011.0191
PROJECT: Lower Llagas
LOCATION: Santa Clara County
INSPECTOR:
CHECKED BY: G. R. Fisher

ELEVATION GROUND LEVEL: N/A
ELEVATION TOP OF CASING: N/A (Approx. El. 175)
DATE STARTED: 3/29/12
DATE FINISHED: 3/29/12
TOTAL DEPTH: 40.0’



DRILLING SUMMARY:

Total Depth: 40 feet
Borehole Diameter: 8 inch
Driller: Exploration Geoservices

Rig: Mobile B-63
Bit(s):

Drilling Fluid: N/A

Protective Casing: N/A

WELL CONSTRUCTION DETAILS:

⊞	**Casing:**	2-inch diameter, flush-threaded, Schedule 40 PVC; locking cap.
☰	**Screen:**	2-inch diameter, flush-threaded, Schedule 40 PVC with 0.010-inch slots.
░	**Filter Pack:**	Monterey #3 sand.
▨	**Bentonite Seal:**	Cetco Pure Gold medium chips.
▩	**Grout Seal:**	Type 1 Portland cement.
▪	**Wire-line Piezometer:**	N/A
	Surface Completion:	Concrete surrounding protective 7-inch steel casing.

WELL CONSTRUCTION LOG:

	Start Date	Start Time	Finish Date	Finish Time
Drilling:	3/29/12		3/29/12	
Coring:				
Ream:				
Casing Install:	3/29/12		3/29/12	
Filter Placement:	3/29/12		3/29/12	
Seal Placement: (Bentonite)	3/29/12		3/29/12	
Seal Placement: (Grout)	3/29/12		3/29/12	

WELL DEVELOPMENT LOG:

Performed by Driller	Date	Start Time	Finish Time
Surge Block	3/29/12	11:00	11:15
Bailing	3/29/12	11:15	11:20
Pumping			

Total Gallons Removed: 5 gal. (est.)

STABILIZATION TEST DATA:

Gallons	pH	Spec. Cond. (us/cm)	Temp (°F)

Comments:

Top of casing 3” below ground surface grade.

WELL MONITORING DATA:

Date	Time	Description	Corr.	Depth (feet)	SWL	By
4/5/12	10:16			22.11		GRF
4/18/12	13:51			21.09		GRF
5/17/12	14:13			21.58		GRF

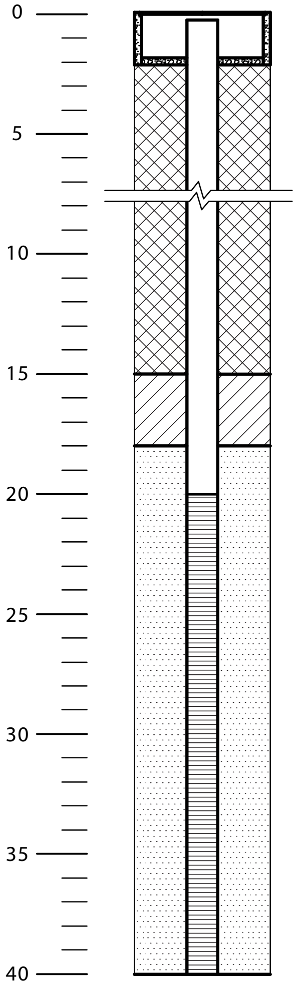
PACIFIC GEOTECHNICAL ENGINEERING
MONITORING WELL COMPLETION SUMMARY

WELL NO.: P-173 + 50W

PAGE: 1 OF 1

JOB NO.: 2011.0191
PROJECT: Lower Llagas
LOCATION: Santa Clara County
INSPECTOR:
CHECKED BY: G. R. Fisher

ELEVATION GROUND LEVEL: N/A
ELEVATION TOP OF CASING: N/A (Approx. El. 185)
DATE STARTED: 3/29/12
DATE FINISHED: 3/29/12
TOTAL DEPTH: 40.0’



DRILLING SUMMARY:

Total Depth: 40 feet
Borehole Diameter: 8 inch
Driller: Exploration Geoservices

Rig: Mobile B-63
Bit(s):

Drilling Fluid: N/A

Protective Casing: N/A

WELL CONSTRUCTION DETAILS:

▭ **Casing:** 2-inch diameter, flush-threaded, Schedule 40 PVC; locking cap.

▤ **Screen:** 2-inch diameter, flush-threaded, Schedule 40 PVC with 0.010-inch slots.

░ **Filter Pack:** Monterey #3 sand.

▨ **Bentonite Seal:** Cetco Pure Gold medium chips.

▩ **Grout Seal:** Type 1 Portland cement.

▭ **Wire-line Piezometer:** N/A

Surface Completion: Concrete surrounding protective 7-inch steel casing.

WELL CONSTRUCTION LOG:

	Start Date	Start Time	Finish Date	Finish Time
Drilling:	3/29/12		3/29/12	
Coring:				
Ream:				
Casing Install:	3/29/12		3/29/12	
Filter Placement:	3/29/12		3/29/12	
Seal Placement: (Bentonite)	3/29/12		3/29/12	
Seal Placement: (Grout)	3/29/12		3/29/12	

WELL DEVELOPMENT LOG:

Performed by Driller	Date	Start Time	Finish Time
Surge Block	3/29/12	15:30	15:45
Bailing	3/29/12	15:45	16:00
Pumping			

Total Gallons Removed: 5 gal. (est.)

STABILIZATION TEST DATA:

Gallons	pH	Spec. Cond. (us/cm)	Temp (°F)

Comments:

Top of casing 3” below ground surface grade.

WELL MONITORING DATA:

Date	Time	Description	Corr.	Depth (feet)	SWL	By
4/5/12	11:02			23.32		GRF
4/18/12	14:26			23.07		GRF
5/17/12	14:38			23.79		GRF

Appendix E

Seepage Analyses

GEI Consultants

Client:	Santa Clara Valley Water District	**Prepared By:**	Tim Haynes/ Len Sansone
Project:	Lower Llagas Creek Capacity Restoration Capital Project	**Date:**	5/17/2012
Project No.:	11540-0	**Checked By:**	Len Sansone
		Date:	6/1/2012

Steady-State Seepage Analysis

Table of Contents:

Steady-State Seepage Analysis Text

Tables

Table E-1 Summary of Seepage Analyses

Figures

Figure E-1 Typical Boundary Conditions
Figure E-2 Station 50+00 Steady-State Seepage Analysis
Figure E-3 Station 78+00 Steady-State Seepage Analysis
Figure E-4 Station 92+50 Steady-State Seepage Analysis
Figure E-5 Station 106+50 Steady-State Seepage Analysis
Figure E-6 Station 126+00 Steady-State Seepage Analysis
Figure E-7 Station 106+50 Steady-State Seepage Analysis with Cut-off Wall

Attachments

Attachment 1 – Seepage Parameters

Analyses Approach and Material Properties

Steady state seepage analyses were performed for five cross section locations along Reaches 1, 2A and 2B where levees were present along Llagas Creek. With the exception of Station 126+00, levees on both the eastern and western banks of the creek were evaluated for a given cross section location. The west side of Section 126+00, and the Sections in Reach 2B at Station 134+00 and 166+50 were not evaluated in SEEP/W for underseepage potential, because these locations are located in channelized creek areas (i.e. a levee underseepage issue is not present). However, the SEEP/W analyses were used to develop steady- state pore pressures for evaluation of waterside rapid drawdown stability in these channelized areas as described in Appendix F.

GEI evaluated seepage using guidance from USACE EM 1110-2-1913, Design and Construction of Levees. The analyses are based on the assumption that steady-state seepage conditions occur when Llagas Creek is at the design water surface elevation. The seepage analyses were performed using SEEP/W, a two-dimensional finite element computer model, developed by GEO-SLOPE International, Ltd. Using SEEP/W, steady-state pore pressures (or phreatic surfaces) were computed within the levee embankment and foundation soils for the design water surface. Average vertical exit gradients (i.e. underseepage gradients) were calculated based on the computed total head contours near the landside toe of the levee embankment. The average vertical exit gradient is the difference in hydraulic head across a relatively impervious upper layer or "blanket" divided by the layer thickness.

The USACE EM 1110-2-1913 indicates that the average vertical exit gradient should be limited to a maximum 0.5 at the levee toe, provided blanket materials have a saturated unit weight in excess of 110 pcf. Due to the very low unit weight and organic nature of the peats, this material was discounted from the overall interpreted blanket thickness in the gradient computation.

Steady-State Seepage Analysis

GEI selected hydraulic conductivities for each soil type based on published ranges of values for different soil types, empirical correlation of grain size to permeabilities (for sand and gravel materials), available hydraulic conductivity test data (for embankment fill materials), and experience from previous evaluations. Attachment 1 includes references to the documents reviewed, estimated hydraulic conductivity values based on soil grain size and selected hydraulic conductivities for the material type modeled in the analysis.

For the seepage evaluation and modeling purposes, nine soil types were identified and evaluated for the cross sections that were modeled by GEI. These soil types include:

- Existing Levee Fill - Lean to Fat Clays (CL and CH soils) according to the Unified Soil Classification System (USCS)
- Softer fine grained alluvial materials of higher plasticity (CH soils) according to the Unified Soil Classification System (USCS)
- Peats (PT soils)
- Peat soils under the levee prism (PT soils)
- Stiffer fine grained alluvial materials (ML, CL, and CH soils)
- Clean coarse grained alluvium - Sands and Gravels with less than 5 percent fines (GP and SP soils) according to the USCS
- Coarse grained alluvium with 5 to 12 percent fines- Sands classified as (SP to SM soils) according to the USCS
- Silty coarse grained alluvium- Sands with more than 12 percent fines classified as (SM soils) according to the USCS
- Artificial fill – Fill materials in channelized areas of the creek at the north end of Reach 2A through Reach 2B- Lean Clays and Silts classified as (ML to CL) soils according to the USCS.

SEEP/W considers flow of moisture through partially saturated soil above the phreatic surface, as well as flow through saturated soil below the phreatic surface. A summary of the permeability values used for the SEEP/W analyses is presented in **Table E-1**. The unit weights of various material types were determined by evaluating in-situ dry density and moisture content data from samples obtained during the subsurface exploration program. **Table E-1** also summarizes material unit weights assigned for the various material types.

Boundary Conditions in the SEEP/W Model

At each cross section analyzed, GEI developed a finite element model of the stratigraphic cross section using the engineering properties shown in **Table E-1** as input. A no-flow boundary condition was applied to the nodes along the bottom of the model, and a constant total head boundary condition was applied to boundary nodes along the channel bottom, the waterside slopes up to the design water surface, and the vertical edges along the landside extents of the model. The constant head boundary condition on the channel bottom and the waterside slopes is equal to the design water surface. The constant head condition on the vertical edges along the landside extents of the model was set equal to the lower elevation of the west or east landside ground surface.

GEI applied a potential seepage face review boundary condition to the nodes along the waterside slope above the design water surface, the levee crest, the landside slope, and the landside ground surface. The potential seepage boundary condition is evaluated for the head at the node after each iteration. If the evaluation shows that water will exit the system at this node, SEEP/W converts the boundary condition to a constant head boundary with the total head equal to the nodes' corresponding elevation and re-computes the solution.

Typical boundary conditions are shown on **Figure E-1**.

SEEP/W Model Results- Existing Levee Conditions

A summary of the results of the seepage evaluation are presented in **Table E-1** and on **Figures E-2** to **E-6**. The calculated average vertical exit gradient (i) ranged from less than 0.1 to 0.6 at the levee toe. The average vertical exit gradient exceeded the USACE maximum of i=0.5 criterion at Station 106+50, due to the thin relatively low permeability blanket materials and more elevated coarse grained alluvial layers beneath the levee prism and levee toe at these Section locations. The calculated average vertical exit gradient was less than (i.e. met the) USACE underseepage criteria for the other four sections that were analyzed.

Due to the relatively impervious nature of the clayey embankment fill materials, through-seepage is not anticipated to be a deficiency that is present for the evaluated Reaches of Llagas Creek.

SEEP/W Model Results- Remediated Levee Conditions

At Station 106+50, a 30-foot deep cut-off wall, which fully penetrated the coarse grained alluvial layer, was modeled in SEEP/W. The cut-off wall was defined in SEEP/W as an interface that did not allow seepage flow across the interface. The results of the seepage evaluation with the cut-off wall are presented in **Table E-1** and on **Figure E-7**. The calculated average vertical exit gradient (i) equaled 0.0 at the levee toe, was less than (i.e. met the) USACE underseepage criteria.

References

Geo-Slope International, Ltd. 2007. Seepage Modeling with SEEP/W 2007. 2nd Edition.

United States Army Corps of Engineers, 2000, Engineer Manual EM 1110-2-1913, Design and Construction of Levees.

TABLE E-1
SUMMARY OF SEEPAGE ANALYSES

Section	Design Water Surface Elevation (ft.)	Model Parameters							Net Head Difference Between Design Water Surface and Landside Toe (ft.)	Estimated Head Beneath Bottom of Blanket Layer (ft.)	Thickness of Blanket Layer (ft.)	Calculate Average Vertical Exit Gradient (ft.)	Notes
			Seepage Parameters					Unit Weight (pcf)					
		Layers	K_h (cm/sec)	K_h (ft/day)	K_h/K_v ratio	K_v (cm/sec)	K_v (ft/day)						
Station 50+00 West (Reach 1)	154.8* *Used 154.0, hydraulic top of levee	**Levee Fill**	1.00E-06	0.003	4	2.50E-07	0.00075	115	10.0	0.0	11.5	0.00	
		Loose Levee Fill	1.00E-06	0.003	4	2.50E-07	0.00075	110					
		Softer Fine Grained Alluvium- CH (Fat Clays)	5.00E-07	0.001	4	1.25E-07	0.00025	110					
		Peat- PT	1.00E-05	0.03	4	2.50E-06	0.0075	70					
		Peat Under Levee- PT	1.00E-06	0.003	4	2.50E-07	0.00075	70					
		Softer Fine Grained Alluvium- CH (Fat Clays)	5.00E-07	0.001	4	1.25E-07	0.00025	110					
		Stiffer Fine Grained Alluvium- Lean to Fat Clays (CL/CH)	5.00E-06	0.01	4	1.25E-06	0.0025	120					
		Clean Coarse Grained Alluvium- Dense Poorly Graded Sands/ Gravel with Sands (GP/SP)	3.50E-02	100	1	3.50E-02	100	140					
		Stiffer Fine Grained Alluvium - Lean Clays (CL)	5.00E-06	0.01	4	1.25E-06	0.0035	120					
Station 50+00 East (Reach 1)	154.8* *Used 154.0, hydraulic top of levee	**Levee Fill**	1.00E-06	0.003	4	2.50E-07	0.00075	115	13.0	1.9	8.5	0.22	
		Loose Levee Fill	1.00E-06	0.003	4	2.50E-07	0.00075						
		Softer Fine Grained Alluvium- CH (Fat Clays)	5.00E-07	0.001	4	1.25E-07	0.00025	110					
		Peat- PT	1.00E-05	0.03	4	2.50E-06	0.0075	70					
		Peat Under Levee- PT	1.00E-06	0.003	4	2.50E-07	0.00075	70					
		Softer Fine Grained Alluvium- CH (Fat Clays)	5.00E-07	0.001	4	1.25E-07	0.00025	110					
		Stiffer Fine Grained Alluvium- Lean to Fat Clays (CL/CH)	5.00E-06	0.01	4	1.25E-06	0.0025	120					
		Clean Coarse Grained Alluvium- Dense Poorly Graded Sands/ Gravel with Sands (GP/SP)	3.50E-02	100	1	3.50E-02	100	140					
		Stiffer Fine Grained Alluvium - Lean Clays (CL)	5.00E-06	0.01	4	1.25E-06	0.0035	120					
Station 78+00 West (Reach2A)	160.5	**Levee Fill**	1.00E-06	0.003	4	2.50E-07	0.00075	115	13.5	1.8	8.0	0.23	
		Softer Fine Grained Alluvium Outside Levee- CH (Fat Clays)	5.00E-07	0.001	4	1.25E-07	0.00025	110					
		Stiffer Fine Grained Alluvium Under Levee - CL	5.00E-06	0.01	4	1.25E-06	0.0025	120					
		Peat- PT	1.00E-05	0.03	4	2.50E-06	0.0075	70					
		Peat Under Levee- PT	1.00E-06	0.003	4	2.50E-07	0.00075	70					
		Stiffer Fine Grained Alluvium- CH (Fat Clays)	5.00E-06	0.01	4	1.25E-06	0.0025	120					
		Coarse Grained Alluvium (>12 percent fines) - Loose to Medium Dense Silty Sand Layer Interbedded with Stiff Lean Clays (SM / CL)	3.50E-04	1	1	3.50E-04	1	120					
		Coarse Grained Alluvium (5 to 12 percent fines) -Medium Dense to Dense Poorly Graded/ Silty Sands (SP/SM)	3.50E-03	10	1	3.50E-03	10	140					
		Stiffer Fine Grained Alluvium - Stiff Lean Clays (CL)	5.00E-06	0.01	4	1.25E-06	0.0025	120					
Station 78+00 East (Reach2A)	160.5	**Levee Fill**	1.00E-06	0.003	4	2.50E-07	0.00075	115	13.5	2.0	13.0	0.15	
		Softer Fine Grained Alluvium Outside Levee - CH (Fat Clays)	5.00E-07	0.001	4	1.25E-07	0.00025	110					
		Stiffer Fine Grained Alluvium Under Levee - CL	5.00E-06	0.01	4	1.25E-06	0.0025	120					
		Peat- PT	1.00E-05	0.03	4	2.50E-06	0.0075	70					
		Peat Under Levee- PT	1.00E-06	0.003	4	2.50E-07	0.00075	70					
		Stiffer Fine Grained Alluvium- CH (Fat Clays)	5.00E-06	0.01	4	1.25E-06	0.0025	120					
		Coarse Grained Alluvium (>12 percent fines) - Loose to Medium Dense Silty Sand Layer Interbedded with Stiff Lean Clays (SM / CL)	3.50E-04	1	1	3.50E-04	1	120					
		Coarse Grained Alluvium (5 to 12 percent fines) -Medium Dense to Dense Poorly Graded/ Silty Sands (SP/SM)	3.50E-03	10	1	3.50E-03	10	140					
		Stiffer Fine Grained Alluvium - Stiff Lean Clays (CL)	5.00E-06	0.01	4	1.25E-06	0.0025	120					
Station 92+50 West (Reach2A)	163.0	**Levee Fill**	1.00E-06	0.003	4	2.50E-07	0.00075	115	13.0	0.3	10.0	0.03	
		Softer Fine Grained Alluvium -CH (Fat Clays)	5.00E-07	0.001	4	1.25E-07	0.00025	110					
		Stiffer Fine Grained Alluvium Under Levee -Stiff Lean Clays and Silts (CL/ ML)	5.00E-06	0.01	4	1.25E-06	0.0025	120					
		Coarse Grained Alluvium (5 to 12 percent fines) -Medium Dense to Dense Poorly Graded/ Silty Sands (SP/SM)	3.50E-03	10	1	3.50E-03	10	140					
		Stiffer Fine Grained Alluvium -Stiff Lean Clays and Silts (CL/ ML)	5.00E-06	0.01	4	1.25E-06	0.0025	120					
Station 92+50 East (Reach2A)	163.0	**Levee Fill**	1.00E-06	0.003	4	2.50E-07	0.00075	115	13.0	0.3	22.0	0.01	
		Softer Fine Grained Alluvium -CH (Fat Clays)	5.00E-07	0.001	4	1.25E-07	0.00025	110					
		Stiffer Fine Grained Alluvium Under Levee -Stiff Lean Clays and Silts (CL/ ML)	5.00E-06	0.01	4	1.25E-06	0.0025	120					
		Stiffer Fine Grained Alluvium -Stiff Lean Clays and Silts (CL/ ML)	5.00E-06	0.01	4	1.25E-06	0.0025	120					
		Coarse Grained Alluvium (5 to 12 percent fines) -Medium Dense to Dense Poorly Graded/ Silty Sands (SP/SM)	3.50E-03	10	1	3.50E-03	10	140					
		Stiffer Fine Grained Alluvium -Stiff Lean Clays and Silts (CL/ ML)	5.00E-06	0.01	4	1.25E-06	0.0025	120					
Station 106+50 West (Reach2A)	165.3	**Levee Fill**	1.00E-06	0.003	4	2.50E-07	0.00075	115	8.6	6.7	10.7	0.63	Levee Section does not meet maximum average vertical exit gradient criteria i=0.5
		Stiffer Fine Grained Alluvium Under Levee - Stiff Lean to Fat Clays (CL/CH)	5.00E-06	0.01	4	1.25E-06	0.0035	120					
		Softer Fine Grained Alluvium Outside Levee	5.00E-07	0.001	4	1.25E-07	0.00025	110					
		Coarse Grained Alluvium (5 to 12 percent fines) -Medium Dense to Dense Silty to Poorly Graded Sands (SM/SP)	3.50E-03	10	1	3.50E-03	10	140					
		Stiffer Fine Grained Alluvium - Stiff Lean Clays and Silts (CL/ ML)	5.00E-06	0.01	4	1.25E-06	0.0035	120					
Station 106+50 East (Reach2A)	165.3	**Levee Fill**	1.00E-06	0.003	4	2.50E-07	0.00075	115	8.1	6.3	11.2	0.56	Levee Section does not meet maximum average vertical exit gradient criteria i=0.5
		Stiffer Fine Grained Alluvium Under Levee - Stiff Lean to Fat Clays (CL/CH)	5.00E-06	0.01	4	1.25E-06	0.0035	120					
		Softer Fine Grained Alluvium Outside Levee	5.00E-07	0.001	4	1.25E-07	0.00025	110					
		Coarse Grained Alluvium (5 to 12 percent fines) -Medium Dense to Dense Silty to Poorly Graded Sands (SM/SP)	3.50E-03	10	1	3.50E-03	10	140					
		Stiffer Fine Grained Alluvium - Stiff Lean Clays and Silts (CL/ ML)	5.00E-06	0.01	4	1.25E-06	0.0035	120					

TABLE E-1
SUMMARY OF SEEPAGE ANALYSES

Section	Design Water Surface Elevation (ft.)	Model Parameters							Net Head Difference Between Design Water Surface and Landside Toe (ft.)	Estimated Head Beneath Bottom of Blanket Layer (ft.)	Thickness of Blanket Layer (ft.)	Calculate Average Vertical Exit Gradient (ft.)	Notes
			Seepage Parameters					Unit Weight (pcf)					
		Layers	K_h (cm/sec)	K_h (ft/day)	K_h/K_v ratio	K_v (cm/sec)	K_v (ft/day)						
Station 126+00 West **(Reach2A)**	169.5	**Stiffer Fine Grained Alluvium -** Stiff to Very Stiff Lean Clay (CL)	5.00E-06	0.01	4	1.25E-06	0.0035	120	N/A	N/A	N/A	N/A	
		Clean Coarse Grained Alluvium - Dense to Very Dense Poorly Graded Sands and Gravels (SP/GP)	3.50E-02	100	1	3.50E-02	100	140					
		Stiffer Fine Grained Alluvium - Stiff Lean Clays and Silts (CL/ ML)	5.00E-06	0.01	4	1.25E-06	0.0035	120					
		Clean Coarse Grained Alluvium- Very Dense Poorly Graded Gravels (GP)	3.50E-02	100	1	3.50E-02	100	140					
		Stiffer Fine Grained Alluvium - Stiff Lean Clays and Silts (CL/ ML)	5.00E-06	0.01	4	1.25E-06	0.0035	120					
Station 126+00 East **(Reach2A)**	169.5	**Levee Fill** (CL/ML)	1.00E-06	0.003	4	2.50E-07	0.00075	115	4.5	3.8	8.0	0.48	
		Stiffer Fine Grained Alluvium Under Levee- Stiff to Very Stiff Lean Clay (CL)	5.00E-06	0.01	4	1.25E-06	0.0035	120					
		Softer Fine Grained Alluvium Outside Levee	5.00E-07	0.001	4	1.25E-07	0.00025	110					
		Clean Coarse Grained Alluvium - Dense to Very Dense Poorly Graded Sands and Gravels (SP/GP)	3.50E-02	100	1	3.50E-02	100	140					
		Stiffer Fine Grained Alluvium - Stiff Lean Clays and Silts (CL/ ML)	5.00E-06	0.01	4	1.25E-06	0.0035	120					
		Clean Coarse Grained Alluvium - Dense to Very Dense Poorly Graded sands and Gravels (SP/GP)	3.50E-02	100	1	3.50E-02	100	140					
		Stiffer Fine Grained Alluvium - Stiff Lean Clays and Silts (CL/ ML)	5.00E-06	0.01	4	1.25E-06	0.0035	120					
Station 134+00 West **(Reach2B)**	170.8	**Artificial Fill -** Stiff Lean Clay Fill Material (CL)	1.00E-06	0.003	4	2.50E-07	0.00075	115	N/A	N/A	N/A	N/A	No levee is present on Section 134+00 West. SEEP/W analysis only to develop slope pore pressure input into rapid drawdown stability analysis of the creek channel
		Stiffer Fine Grained Alluvium-Stiff to Very Stiff Lean Clay (CL)	5.00E-06	0.01	4	1.25E-06	0.0035	120					
		Coarse Grained Alluvium (5 to 12 percent fines) -Loose to Medium Dense Poorly Graded Sands with Silt (SP/SM)	3.50E-03	10	1	3.50E-03	10	140					
		Clean Coarse Grained Alluvium - Dense to Very Dense Poorly Graded Sands and Gravels (SP/GP)	3.50E-02	100	1	3.50E-02	100	140					
		Stiffer Fine Grained Alluvium- Stiff Lean Clays and Silts (CL/ ML)	5.00E-06	0.01	4	1.25E-06	0.0035	120					
Station 134+00 East **(Reach2B)**	170.8	**Levee Fill** (CH)	1.00E-06	0.003	4	2.50E-07	0.00075	115	N/A	N/A	N/A	N/A	The levee on the east side of Section 134+00 is above the design water surface and provides a minimum 3-feet of freeboard protection. SEEP/W analysis only to develop slope pore pressure input into rapid drawdown stability analysis of the creek channel
		Stiffer Fine Grained Alluvium- Stiff to Very Stiff Lean/ Fat Clay (CL/CH)	5.00E-06	0.01	4	1.25E-06	0.0035	120					
		Coarse Grained Alluvium (5 to 12 percent fines) -Loose to Medium Dense Poorly Graded Sands with Silt (SP/SM)	3.50E-03	10	1	3.50E-03	10	140					
		Clean Coarse Grained Alluvium- Dense to Very Dense Poorly Graded sands and Gravels (SP/GP)	3.50E-02	100	1	3.50E-02	100	140					
		Stiffer Fine Grained Alluvium-Stiff Lean Clays (CL)	5.00E-06	0.01	4	1.25E-06	0.0035	120					
Station 166+50 West **(Reach 2B)**	177.8	**Artificial Fill-** Stiff Lean Clay Fill Material (CL)	1.00E-06	0.003	4	2.50E-07	0.00075	115	N/A	N/A	N/A	N/A	The levee on the west side of Section 166+50 is above the design water surface and above the 3-foot freeboard elevation for the design water surface. SEEP/W analysis only to develop slope pore pressure input into rapid drawdown stability analysis of the creek channel
		Coarse Grained Alluvium (>12 percent fines) - Loose to Medium Dense Silty Sand Layer Interbedded with Stiff Lean Clays (SM / CL)	3.50E-04	1	1	3.50E-04	1	120					
		Stiff Fine Grained Alluvium- Stiff to Very Stiff Lean Clay (CL)	5.00E-06	0.01	4	1.25E-06	0.0035	120					
		Coarse Grained Alluvium (5 to 12 percent fines) - Medium Dense Poorly Graded Sands with Silt (SP/SM)	3.50E-03	10	1	3.50E-03	10	140					
		Clean Coarse Grained Alluvium- Dense to Very Dense Poorly Graded Sands and Gravels (SP/GP)	3.50E-02	100	1	3.50E-02	100	140					
		Stiff Fine Grained Alluvium-Stiff Lean Clays and Silts (CL/ ML)	5.00E-06	0.01	4	1.25E-06	0.0035	120					
Station 166+50 East **(Reach 2B)**	177.8	**Artificial Fill-** Stiff Lean Clay Fill Material (CL)	1.00E-06	0.003	4	2.50E-07	0.00075	115	N/A	N/A	N/A	N/A	No levee is present on Section 166+50 East. SEEP/W analysis only to develop slope pore pressure input into rapid drawdown stability analysis of the creek channel
		Coarse Grained Alluvium (>12 percent fines) - Loose to Medium Dense Silty Sand Layer Interbedded with Stiff Lean Clays (SM / CL)	3.50E-04	1	1	3.50E-04	1	120					
		Stiff Fine Grained Alluvium- Stiff to Very Stiff Lean Clay (CL)	5.00E-06	0.01	4	1.25E-06	0.0035	120					
		Coarse Grained Alluvium (5 to 12 percent fines) - Medium Dense Poorly Graded Sands with Silt (SP/SM)	3.50E-03	10	1	3.50E-03	10	140					
		Clean Coarse Grained Alluvium- Dense to Very Dense Poorly Graded Sands and Gravels (SP/GP)	3.50E-02	100	1	3.50E-02	100	140					
		Stiff Fine Grained Alluvium-Stiff Lean Clays and Silts (CL/ ML)	5.00E-06	0.01	4	1.25E-06	0.0035	120					
Station 106+50 West **with Cut-off Wall** **(Reach2A)**	165.3	**Levee Fill**	1.00E-06	0.003	4	2.50E-07	0.00075	115	8.6	0.0	10.7	0.00	
		Stiffer Fine Grained Alluvium Under Levee - Stiff Lean to Fat Clays (CL/CH)	5.00E-06	0.01	4	1.25E-06	0.0035	120					
		Softer Fine Grained Alluvium Outside Levee	5.00E-07	0.001	4	1.25E-07	0.00025	110					
		Coarse Grained Alluvium (5 to 12 percent fines) -Medium Dense to Dense Silty to Poorly Graded Sands (SM/SP)	3.50E-03	10	1	3.50E-03	10	140					
		Stiffer Fine Grained Alluvium - Stiff Lean Clays and Silts (CL/ ML)	5.00E-06	0.01	4	1.25E-06	0.0035	120					
Station 106+50 East **with Cut-off Wall** **(Reach2A)**	165.3	**Levee Fill**	1.00E-06	0.003	4	2.50E-07	0.00075	115	8.1	0.0	11.2	0.00	
		Stiffer Fine Grained Alluvium Under Levee - Stiff Lean to Fat Clays (CL/CH)	5.00E-06	0.01	4	1.25E-06	0.0035	120					
		Softer Fine Grained Alluvium Outside Levee	5.00E-07	0.001	4	1.25E-07	0.00025	110					
		Coarse Grained Alluvium (5 to 12 percent fines) -Medium Dense to Dense Silty to Poorly Graded Sands (SM/SP)	3.50E-03	10	1	3.50E-03	10	140					
		Stiffer Fine Grained Alluvium - Stiff Lean Clays and Silts (CL/ ML)	5.00E-06	0.01	4	1.25E-06	0.0035	120					

Lower Llagas Creek Capacity Restoration Capital Project

Station 50+00 Steady-State Seepage Analysis

Model stratigraphy and characteristics developed using geologic information from CPT-049+00E, B-050+00W, and CPT-050+00W
Topography based on 2007 LiDAR data provided by SCVWD for Project use
Design Water Surface Elevation (Design WSE) provided by SCVWD
All elevations reference North American Vertical Datum of 1988 (NAVD88)

Analysis Section Details

Design WSE* - 154.8'
*Design WSE greater than top of levees, therefore, the analysis was run at WSE - 154.0'

	West Levee	East Levee
Crest Elevation	154.1'	154.0'
Crest Width	22.3'	26.0'
Waterside Slope	2.5H:1V	2.7H:1V
Waterside Toe Elevation	139.0'	138.0'
Landside Slope	3.3H:1V	2.2H:1V
Landside Toe Elevation	144.0'	141.0'

Levee Fill
K-Sat: 0.003 ft/day
Kv/Kh: 0.25

Peat
Under Levee Prism
K-Sat: 0.003 ft/day
Kv/Kh: 0.25
Outside Levee Prism
K-Sat: 0.03 ft/day
Kv/Kh: 0.25

Coarse Grained Alluvium < 5% Fines
K-Sat: 100 ft/day
Kv/Kh: 1

Softer Fine Grained Alluvium
K-Sat: 0.001 ft/day
Kv/Kh: 0.25

Stiffer Fine Grained Alluvium
K-Sat: 0.01 ft/day
Kv/Kh: 0.25

Loose Levee Fill
K-Sat: 0.003 ft/day
Kv/Kh: 0.25

The constant head boundaries were applied to the vertical edges along the landside extents of the model, approximately 750 feet from the center of the creek in each direction.

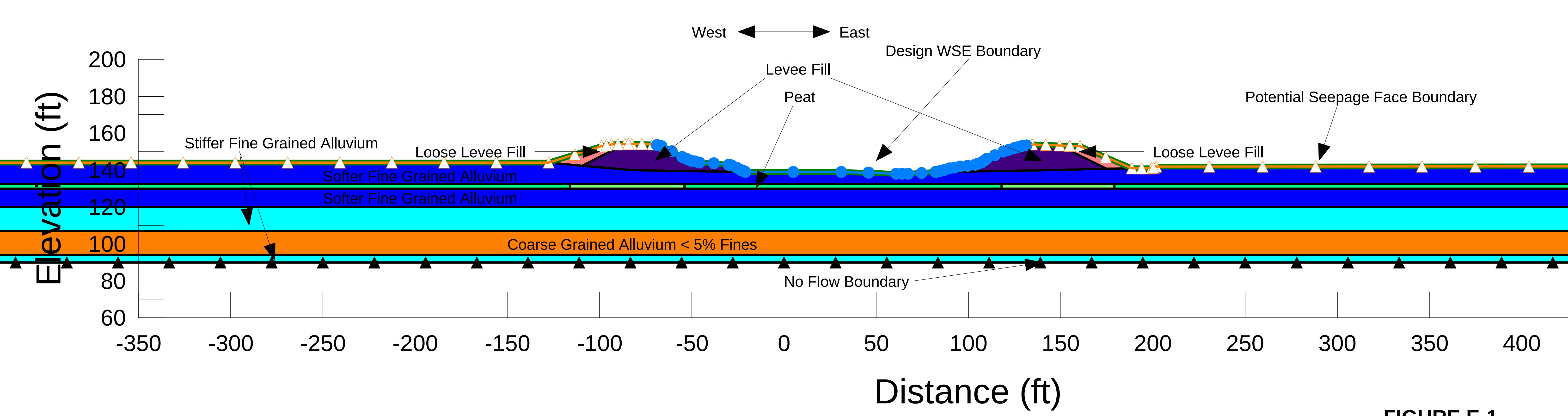


FIGURE E-1

Lower Llagas Creek Capacity Restoration Capital Project

Station 50+00 Steady-State Seepage Analysis

Model stratigraphy and characteristics developed using geologic information
from CPT-049+00E, B-050+00W, and CPT-050+00W
Topography based on 2007 LiDAR data provided by SCVWD for Project use
Design Water Surface Elevation (Design WSE) provided by SCVWD
All elevations reference North American Vertical Datum of 1988 (NAVD88)

Levee Fill
K-Sat: 0.003 ft/day
Kv/Kh: 0.25

Peat
Under Levee Prism
K-Sat: 0.003 ft/day
Kv/Kh: 0.25
Outside Levee Prism
K-Sat: 0.03 ft/day
Kv/Kh: 0.25

Coarse Grained Alluvium < 5% Fines
K-Sat: 100 ft/day
Kv/Kh: 1

Softer Fine Grained Alluvium
K-Sat: 0.001 ft/day
Kv/Kh: 0.25

Stiffer Fine Grained Alluvium
K-Sat: 0.01 ft/day
Kv/Kh: 0.25

Loose Levee Fill
K-Sat: 0.003 ft/day
Kv/Kh: 0.25

Analysis Section Details

Design WSE* - 154.8'
*Design WSE greater than top of levees, therefore, the analysis was run at WSE - 154.0'

	West Levee	East Levee
Crest Elevation	154.1'	154.0'
Crest Width	22.3'	26.0'
Waterside Slope	2.5H:1V	2.7H:1V
Waterside Toe Elevation	139.0'	138.0'
Landside Slope	3.3H:1V	2.2H:1V
Landside Toe Elevation	144.0'	141.0'
Average Vertical Exit Gradient (i) Landside	0.00	0.22

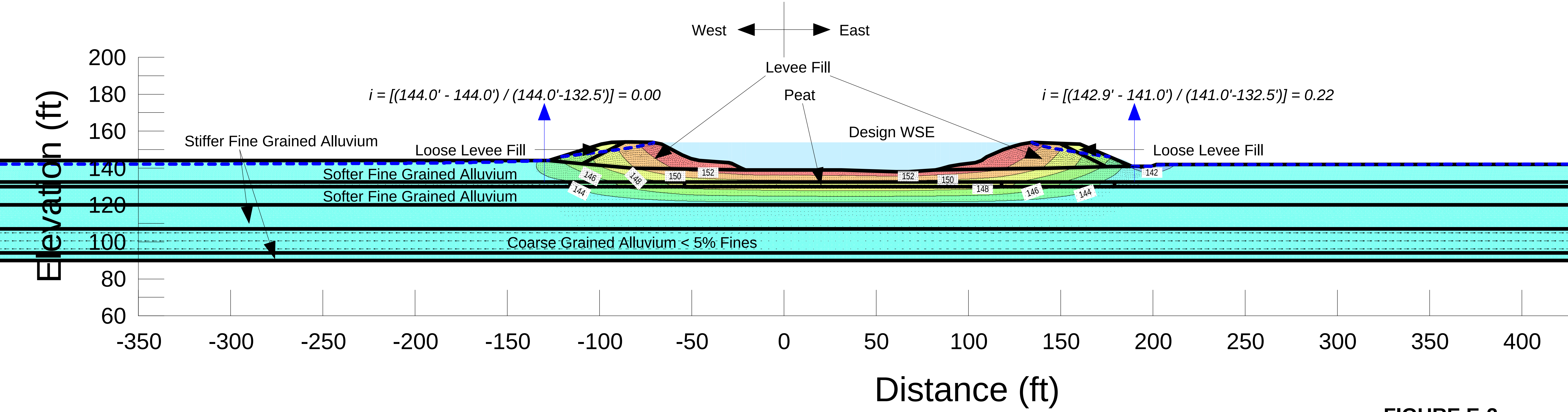

West
East
Levee Fill
Peat
Design WSE
i = [(144.0' - 144.0') / (144.0'-132.5')] = 0.00
i = [(142.9' - 141.0') / (141.0'-132.5')] = 0.22
Stiffer Fine Grained Alluvium
Loose Levee Fill
Loose Levee Fill
Softer Fine Grained Alluvium
Softer Fine Grained Alluvium
Coarse Grained Alluvium < 5% Fines
146
148
150
152
144
152
150
148
146
144
142
Elevation (ft)
200
180
160
140
120
100
80
60
-350
-300
-250
-200
-150
-100
-50
0
50
100
150
200
250
300
350
400
Distance (ft)

FIGURE E-2

Lower Llagas Creek Capacity Restoration Capital Project

Station 78+00 Steady-State Seepage Analysis

Model stratigraphy and characteristics developed using geologic information
from B-078+00W, CPT-078+00W, and CPT-074+50E
Topography based on 2007 LiDAR data provided by SCVWD for Project use
Design Water Surface Elevation (Design WSE) provided by SCVWD
All elevations reference North American Vertical Datum of 1988 (NAVD 1988)

Analysis Section Details

Design WSE - 160.5'

	West Levee	East Levee
Crest Elevation	163.0'	162.2'
Crest Width	56.0'	18.2'
Waterside Slope	2.3H:1V	2.3H:1V
Waterside Toe Elevation	142.0'	141.0'
Landside Slope	2.7H:1V	2.2H:1V
Landside Toe Elevation	147.0'	147.0'
Average Vertical Exit Gradient (i) Landside*	0.23	0.15

Levee Fill
K-Sat: 0.003 ft/day
Kv/Kh: 0.25

Peat
Under Levee Prism
K-Sat: 0.003 ft/day
Kv/Kh: 0.25
Outside Levee Prism
K-Sat: 0.03 ft/day
Kv/Kh: 0.25

Coarse Grained Alluvium > 12% Fines
K-Sat: 1 ft/day
Kv/Kh: 1

Softer Fine Grained Alluvium
K-Sat: 0.001 ft/day
Kv/Kh: 0.25

Stiffer Fine Grained Alluvium
K-Sat: 0.01 ft/day
Kv/Kh: 0.25

Coarse Grained Alluvium 5% < Fines < 12%
K-Sat: 10 ft/day
Kv/Kh: 1

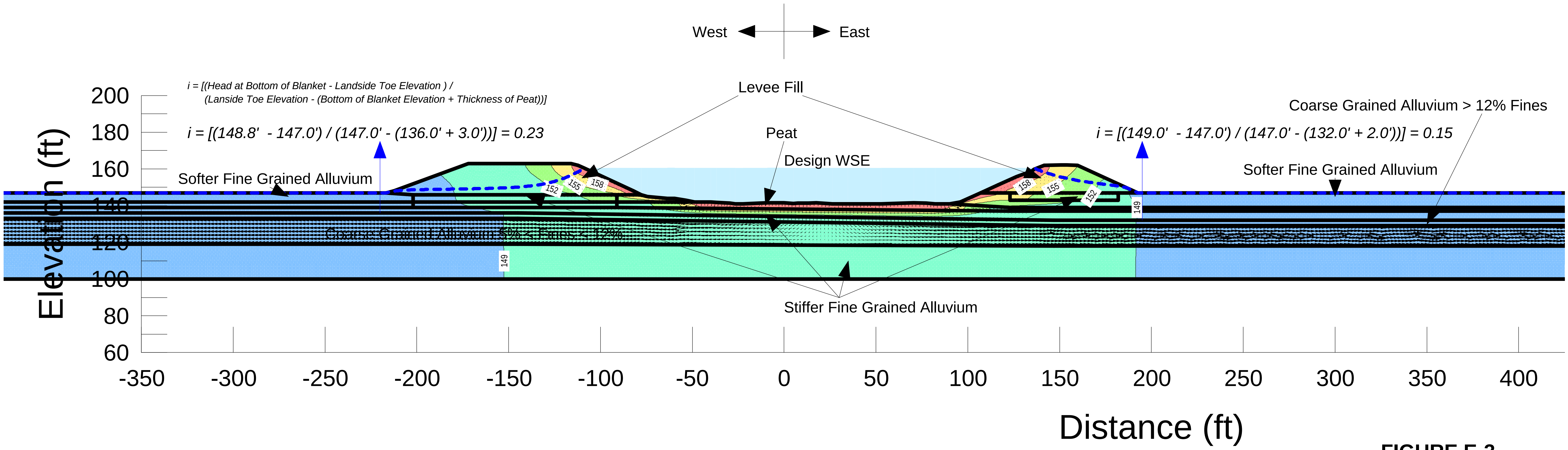


FIGURE E-3

Lower Llagas Creek Capacity Restoration Capital Project

Station 92+50 Steady-State Seepage Analysis

Model stratigraphy and characteristics developed using geologic information
from B-092+50W, B-092+50E, and CPT-092+50E
Topography based on 2007 LiDAR data provided by SCVWD for Project ues
Design Water Surface Elevation (Design WSE) provided by SCVWD
All elevations reference North American Vertical Datum of 1988 (NAVD88)

Levee Fill
K-Sat: 0.003 ft/day
Kv/Kh: 0.25

Stiffer Fine Grained Alluvium
K-Sat: 0.01 ft/day
Kv/Kh: 0.25

Softer Fine Grained Alluvium
K-Sat: 0.001 ft/day
Kv/Kh: 0.25

Coarse Grained Alluvium 5% < Fines < 12%
K-Sat: 10 ft/day
Kv/Kh: 1

Analysis Section Details

Design WSE - 163.0'

	West Levee	East Levee
Crest Elevation	164.0'	164.0'
Crest Width	24.0'	15.6'
Waterside Slope	2.8H:1V	3.2H:1V
Waterside Toe Elevation	143.0'	144.0'
Landside Slope	3.2H:1V	2.6H:1V
Landside Toe Elevation	150.0'	150.0'
Average Vertical Exit Gradient (i) Landside	0.03	0.01

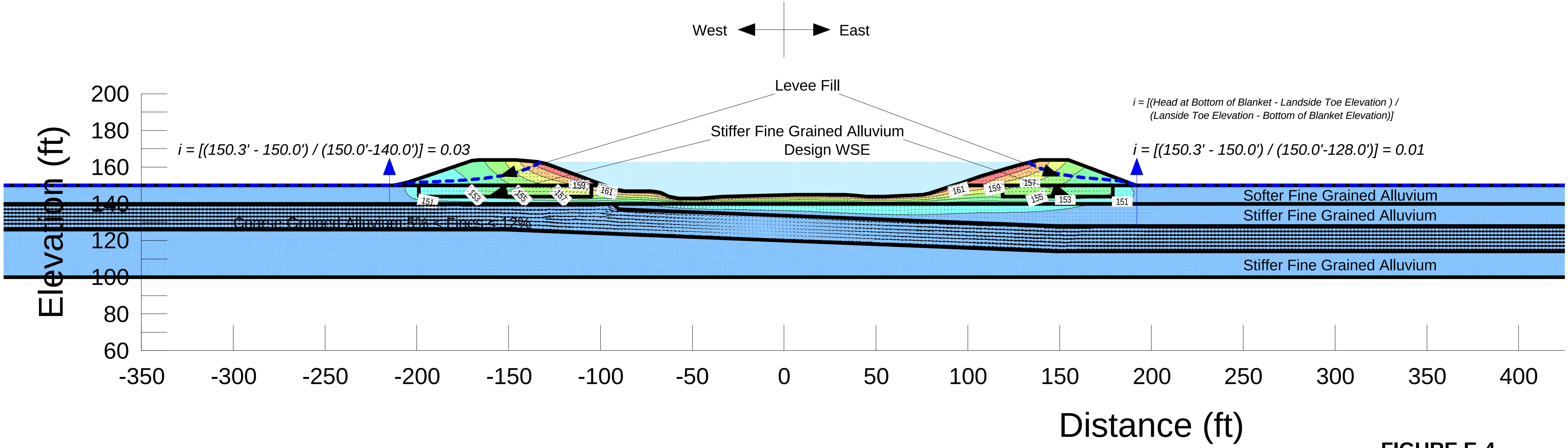


FIGURE E-4

Lower Llagas Creek Capacity Restoration Capital Project

Station 106+50 Steady-State Seepage Analysis

Model stratigraphy and characteristics developed using geologic information
from B-107+00W, CPT-107+00W, and CPT-108+50E
Topography based on 2007 LiDAR data provided by SCVWD for Project use
Design Water Surface Elevation (Design WSE) provided by SCVWD
All elevations reference North American Vertical Datum of 1988 (NAVD88)

Levee Fill
K-Sat: 0.003 ft/day
Kv/Kh: 0.25

Stiffer Fine Grained Alluvium
K-Sat: 0.01 ft/day
Kv/Kh: 0.25

Softer Fine Grained Alluvium
K-Sat: 0.001 ft/day
Kv/Kh: 0.25

Coarse Grained Alluvium 5% < Fines < 12%
K-Sat: 10 ft/day
Kv/Kh: 1

Analysis Section Details

Design WSE - 165.3'

	West Levee	East Levee
Crest Elevation	166.0'	166.0'
Crest Width	34.0'	15.7'
Waterside Slope	3.2H:1V	2.1H:1V
Waterside Toe Elevation	145.0'	147.5'
Landside Slope	3.3H:1V	3.3H:1V
Landside Toe Elevation	156.7'	157.2'
Average Vertical Exit Gradient (i) Landside	0.63	0.56

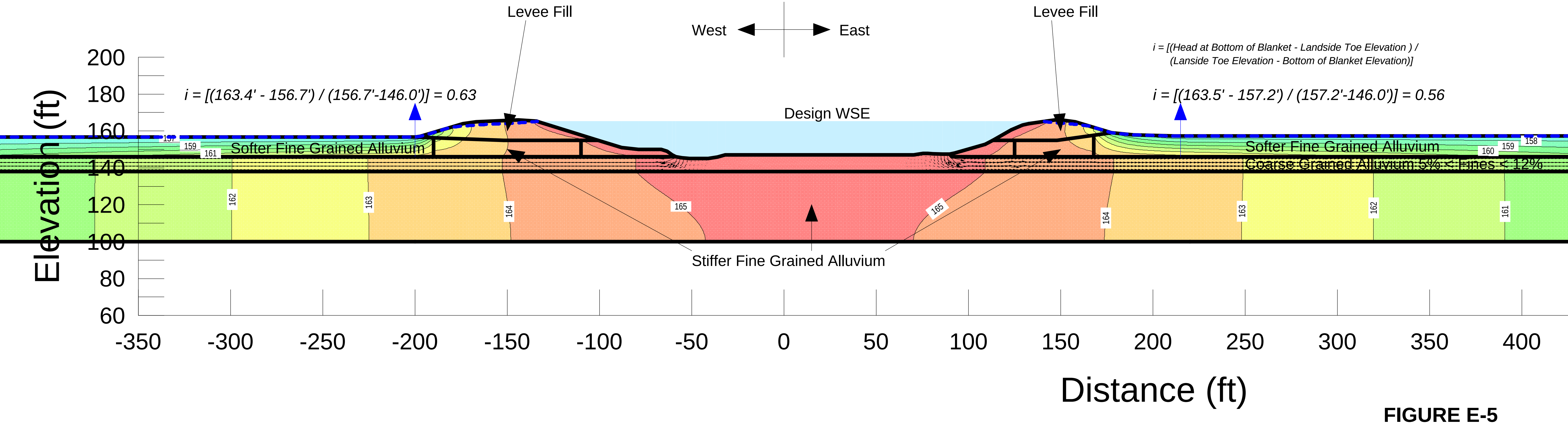


FIGURE E-5

Lower Llagas Creek Capacity Restoration Capital Project

Station 126+00 Steady-State Seepage Analysis

Model stratigraphy and characteristics developed using geologic information
from CPT-126+00E and B-127+00W
Topography based on 2007 LiDAR data provided by SCVWD for Project use
Design Water Surface Elevation (Design WSE) provided by SCVWD
All elevations reference North American Vertical Datum of 1988 (NAVD88)

Analysis Section Details

Design WSE - 169.5'

East Levee

Levee Fill
K-Sat: 0.003 ft/day
Kv/Kh: 0.25

Stiffer Fine Grained Alluvium
K-Sat: 0.01 ft/day
Kv/Kh: 0.25

Coarse Grained Alluvium < 5% Fines
K-Sat: 100 ft/day
Kv/Kh: 1

Softer Fine Grained Alluvium
K-Sat: 0.001 ft/day
Kv/Kh: 0.25

Crest Elevation	173.0'
Crest Width	57.6'
Waterside Slope	2.4H:1V
Waterside Toe Elevation	151.0'
Landside Slope	2.1H:1V
Landside Toe Elevation	165.0'
Average Vertical Exit Gradient (i) Landside	0.48

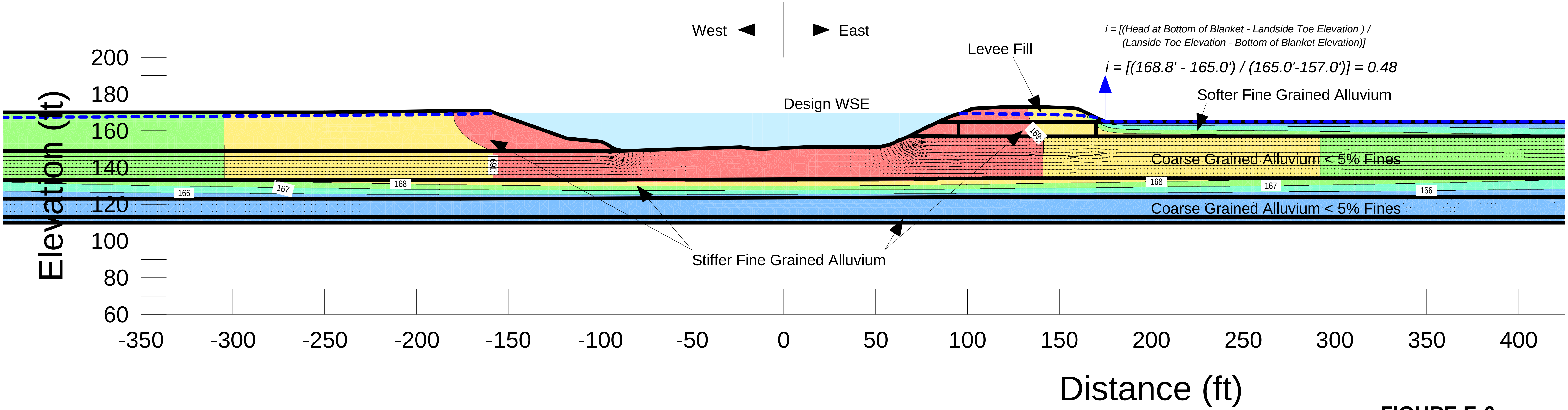

West
East
Levee Fill
i = [(Head at Bottom of Blanket - Landside Toe Elevation) / (Lanside Toe Elevation - Bottom of Blanket Elevation)]
i = [(168.8' - 165.0') / (165.0'-157.0')] = 0.48
Softer Fine Grained Alluvium
Design WSE
Coarse Grained Alluvium < 5% Fines
Coarse Grained Alluvium < 5% Fines
Stiffer Fine Grained Alluvium
169
169
166
167
168
168
167
166
200
180
160
140
120
100
80
60
Elevation (ft)
-350
-300
-250
-200
-150
-100
-50
0
50
100
150
200
250
300
350
400
Distance (ft)

FIGURE E-6

Lower Llagas Creek Capacity Restoration Capital Project

Station 106+50 Steady-State Seepage Analysis

Model stratigraphy and characteristics developed using geologic information
from B-107+00W, CPT-107+00W, and CPT-108+50E
Topography based on 2007 LiDAR data provided by SCVWD for Project use
Design Water Surface Elevation (Design WSE) provided by SCVWD
All elevations reference North American Vertical Datum of 1988 (NAVD88)

Analysis Section Details
Design WSE - 165.3'

	West Levee	East Levee
Top Cut-off Wall Elevation	168.3'	168.3'
Bottom Cut-off Wall Elevation	135.3'	135.3'
Waterside Slope	3.2H:1V	2.1H:1V
Waterside Toe Elevation	145.0'	147.5'
Landside Slope	3.3H:1V	3.3H:1V
Landside Toe Elevation	156.7'	157.2'
Average Vertical Exit Gradient (i) Landside	0.00	0.00

Levee Fill
K-Sat: 0.003 ft/day
Kv/Kh: 0.25

Stiffer Fine Grained Alluvium
K-Sat: 0.01 ft/day
Kv/Kh: 0.25

Floodwall
K-Transpose: 0 ft/days
K-Normal: 0 ft/days

Softer Fine Grained Alluvium
K-Sat: 0.001 ft/day
Kv/Kh: 0.25

Coarse Grained Alluvium 5% < Fines < 12%
K-Sat: 10 ft/day
Kv/Kh: 1

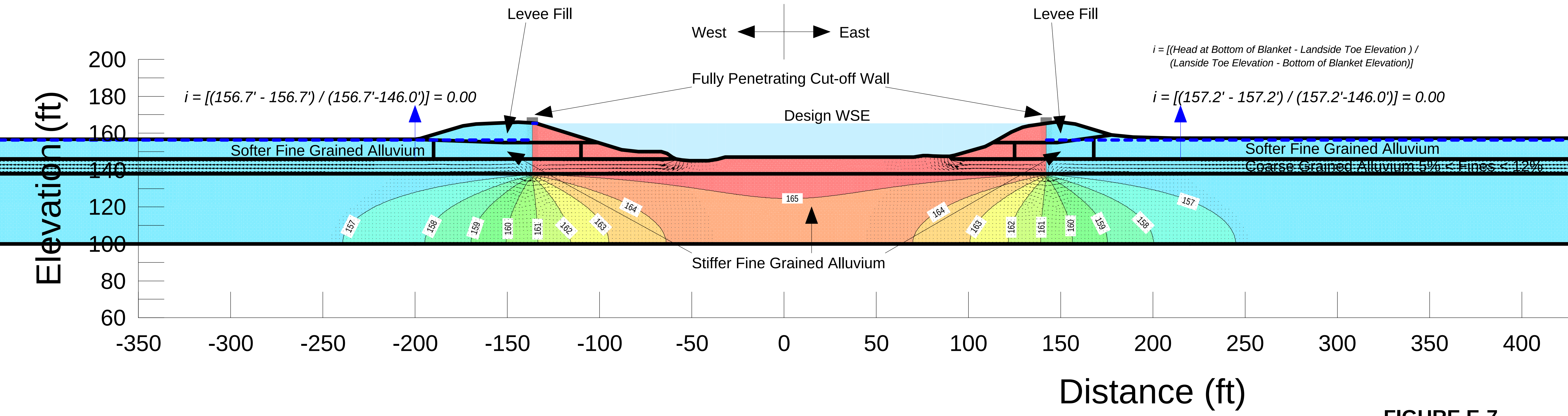

Levee Fill
West
East
Levee Fill
i = [(Head at Bottom of Blanket - Landside Toe Elevation) /
(Landside Toe Elevation - Bottom of Blanket Elevation)]
Fully Penetrating Cut-off Wall
i = [(156.7' - 156.7') / (156.7'-146.0')] = 0.00
i = [(157.2' - 157.2') / (157.2'-146.0')] = 0.00
Design WSE
Softer Fine Grained Alluvium
Softer Fine Grained Alluvium
Coarse Grained Alluvium 5% < Fines < 12%
165
164
157
158
159
160
161
162
163
164
163
162
161
160
159
158
157
Stiffer Fine Grained Alluvium
Elevation (ft)
200
180
160
140
120
100
80
60
-350
-300
-250
-200
-150
-100
-50
0
50
100
150
200
250
300
350
400
Distance (ft)

FIGURE E-7

Attachment 1 – Seepage Parameters

GEI Consultants

Client: Santa Clara Valley Water District
Project: Lower Llagas Creek Capacity Restoration Capital Project
Project No.: 11540-0
Prepared By: T. Haynes/ Len Sansone
Date: 5/15/12
Checked By: L. Sansone
Date: 6/1/2012

Seepage Parameters

Purpose:

Estimate hydraulic conductivity values in the proposed embankment and foundation materials for the Lower Llagas Creek Levees

References:

(1) U.S. Army Corps of Engineers (Corps), 1986, Seepage Analysis and Control for Dams, EM 1110-2-1901, September 30.
(2) Federal Highway Administration (FHWA), 2002, Geotechnical Engineering Circular No. 5 Evaluation of Soil and Rock Properties, FHWA-IF-02-034, April.
(3) Terzaghi K. and Peck, R. 1948, Soil Mechanics in Engineering Practice, John Wiley & Sons, New York.
(4) Cedergren, H.,1989, Seepage, Drainage, and Flow Nets, John Wiley & Sons, New York.
(5) Peck, Hanson & Thornburn, 1974, Foundation Engineering, John Wiley & Sons, Inc., New York.
(6) Naval Facilities Engineering Command (NAVFAC), 1982, Foundations and Earth Structures, Design Manual 7.2, May.
(7) Mitchell, J.K., 1993, Fundamentals of Soil Behavior, John Wiley and Sons, New York.
(8) Lambe, T.W., and Whitman, R.V., 1969, Soil Mechanics, John Wiley and Sons, New York.
(9) CESPK Levee Task Force, 2003, Recommendations for Seepage Design Criteria, Evaluation and Design Practices.
(10) Turnbull, W.J. and Mansur, C.I., 1959, Investigation of Underseepage – Mississippi River Levees, Journal of the Soil Mechanics and Foundation Division, ASCE, SM 4 August.
(11) URS, Inc., 2011, Guidance Document for Geotechnical Analyses: Urban Levee Geotechnical Evaluations Program, Revision 10, Department of Water Resources, State of California, September.
(12) Association of State Dam Safety Officials (ASDSO), 2010, Empirical Estimates for Permiability-Webinar.
(13) Chapuis, R.P., and Aubertin, M., 2003, On the Use of the Kozeny-Carman Equation to Predict the Hydraulic Conductivity of Soils, Canadian Geotechnical Journal.
(14) GEI Consultants, Inc (2009), Twitchell Island Levee Improvement Project, San Joaquin River Reach, January 2009.
(15) Mesri, G. and Ajlouni, M. (2007), Engineering Properties of Fibrous Peats, Journal of Geotechnical and Geoenvironmental Engineering, ASCE, Vol. 133, No. 7, July 2007.

Approach:

GEI reviewed published hydraulic conductivity values for different soil types, test results, and selected design hydraulic conductivity values based on soil type, published values, and experience from previous investigations.

Analysis:

Hydraulic Conductivities Based on Published Ranges

We estimated hydraulic conductivities for the different soil types observed in test borings along the levee alignment based on published ranges for material types and on experience from previous investigations.

Published Ranges for Material Types

From EM 1110-2-1901, pages 2-10, the following figure is given:

Seepage Parameters

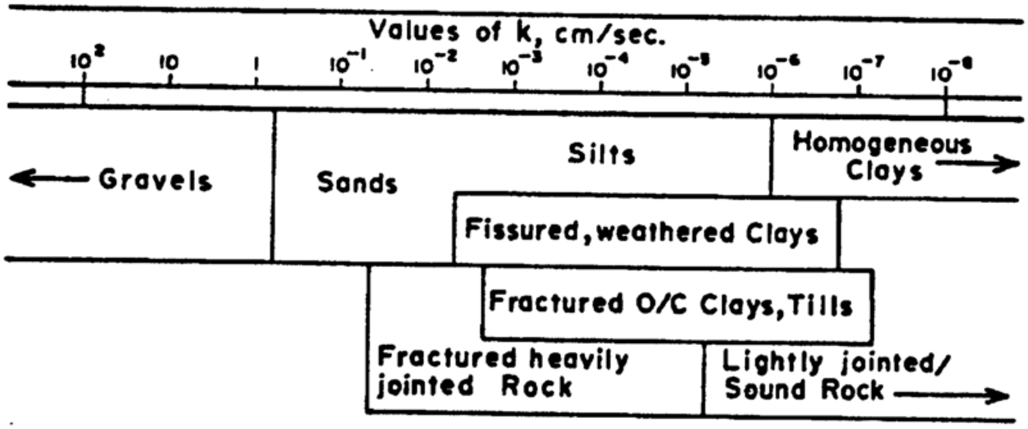


Figure 2-5. Approximate range in coefficient of permeability of soils and rocks (from Milligan[224])

Client: Santa Clara Valley Water District

Project: Lower Llagas Creek Capacity Restoration Capital Project

Project No.: 11540-0

Prepared By: T. Haynes/ Len Sansone

Date: 5/15/12

Checked By: L. Sansone

Date: 6/1/2012

Seepage Parameters

From FHWA-IF-02-034, the following figure is given:

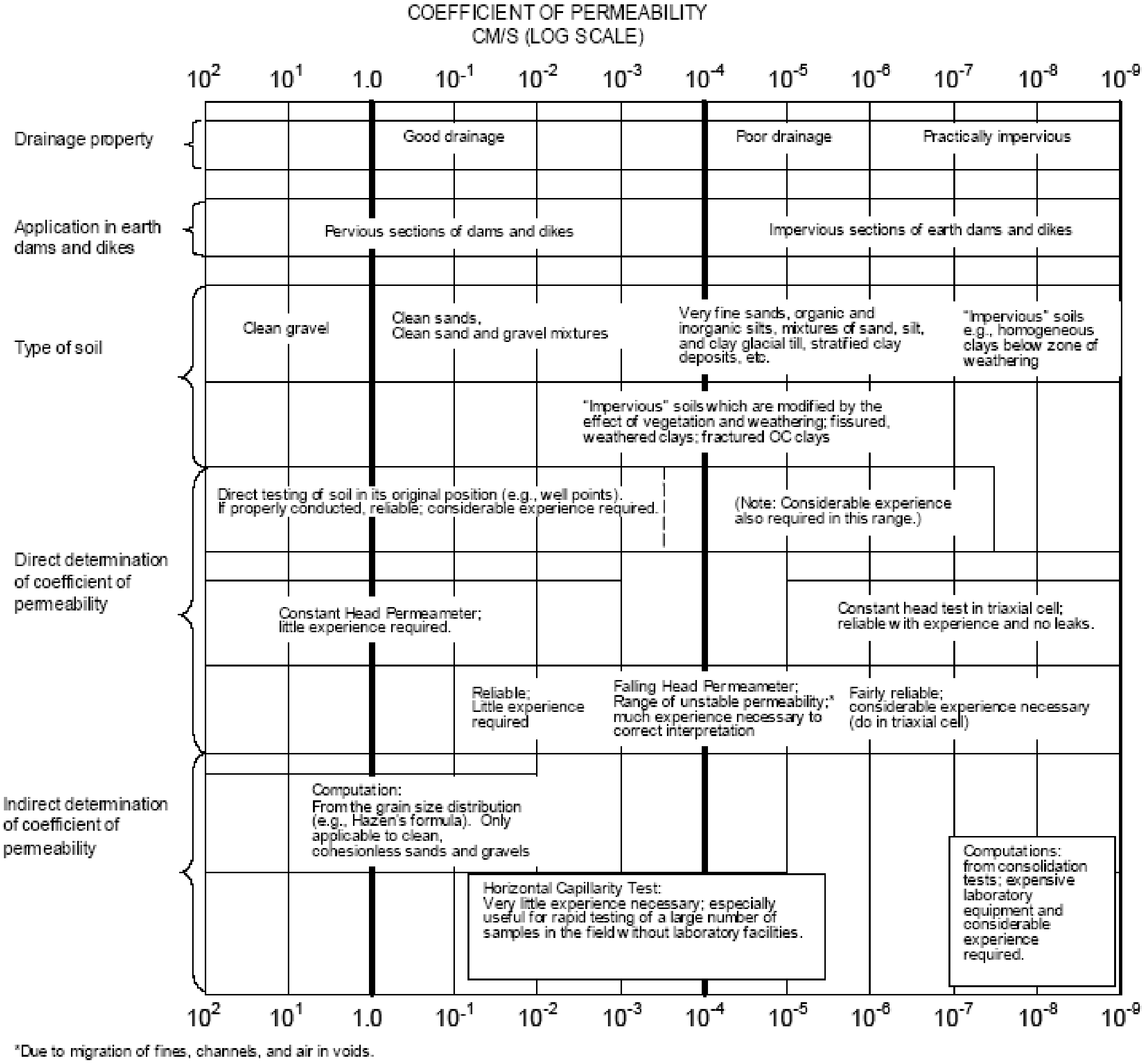


Figure 90. Range of hydraulic conductivity values based on soil type.

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Client: Santa Clara Valley Water District
Project: Lower Llagas Creek Capacity Restoration Capital Project
Project No.: 11540-0

Prepared By: T. Haynes/ Len Sansone
Date: 5/15/12
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Date: 6/1/2012

Seepage Parameters

Terzaghi and Peck (1948), Peck, Hanson, and Thornburn (1974), and Cedergren (1989) all reference the following table:

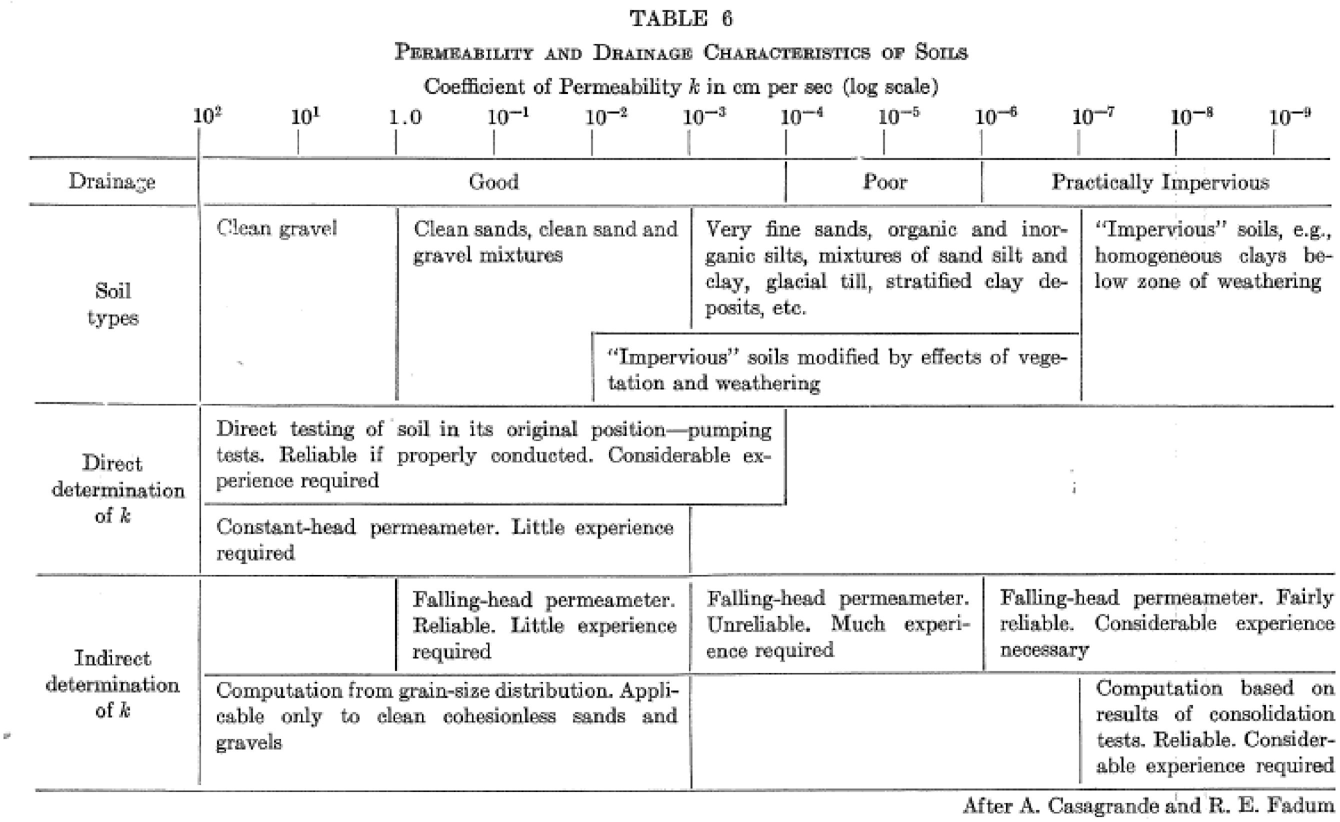


TABLE 6

PERMEABILITY AND DRAINAGE CHARACTERISTICS OF SOILS

Coefficient of Permeability k in cm per sec (log scale)

10^2 10^1 1.0 10^{-1} 10^{-2} 10^{-3} 10^{-4} 10^{-5} 10^{-6} 10^{-7} 10^{-8} 10^{-9}

Drainage	Good				Poor	Practically Impervious	
Soil types	Clean gravel	Clean sands, clean sand and gravel mixtures		Very fine sands, organic and inorganic silts, mixtures of sand silt and clay, glacial till, stratified clay deposits, etc.			"Impervious" soils, e.g., homogeneous clays below zone of weathering
			"Impervious" soils modified by effects of vegetation and weathering				
Direct determination of k	Direct testing of soil in its original position—pumping tests. Reliable if properly conducted. Considerable experience required						
	Constant-head permeameter. Little experience required						
Indirect determination of k		Falling-head permeameter. Reliable. Little experience required		Falling-head permeameter. Unreliable. Much experience required		Falling-head permeameter. Fairly reliable. Considerable experience necessary	
	Computation from grain-size distribution. Applicable only to clean cohesionless sands and gravels						Computation based on results of consolidation tests. Reliable. Considerable experience required

After A. Casagrande and R. E. Fadum

The reference for this table is:

Casagrande, A., and R.E. Fadum (1940), "Notes on Soil Testing for Engineering Purposes", Harvard University Graduate School of Engineering Publication No. 8, 74pp.

GEI Consultants

Client: Santa Clara Valley Water District
Project: Lower Llagas Creek Capacity Restoration Capital Project
Project No.: 11540-0

Prepared By: T. Haynes/ Len Sansone
Date: 5/15/12
Checked By: L. Sansone
Date: 6/1/2012

Seepage Parameters

NAVFAC DM 7.2 provides the following table to estimate hydraulic conductivity of compacted soils:

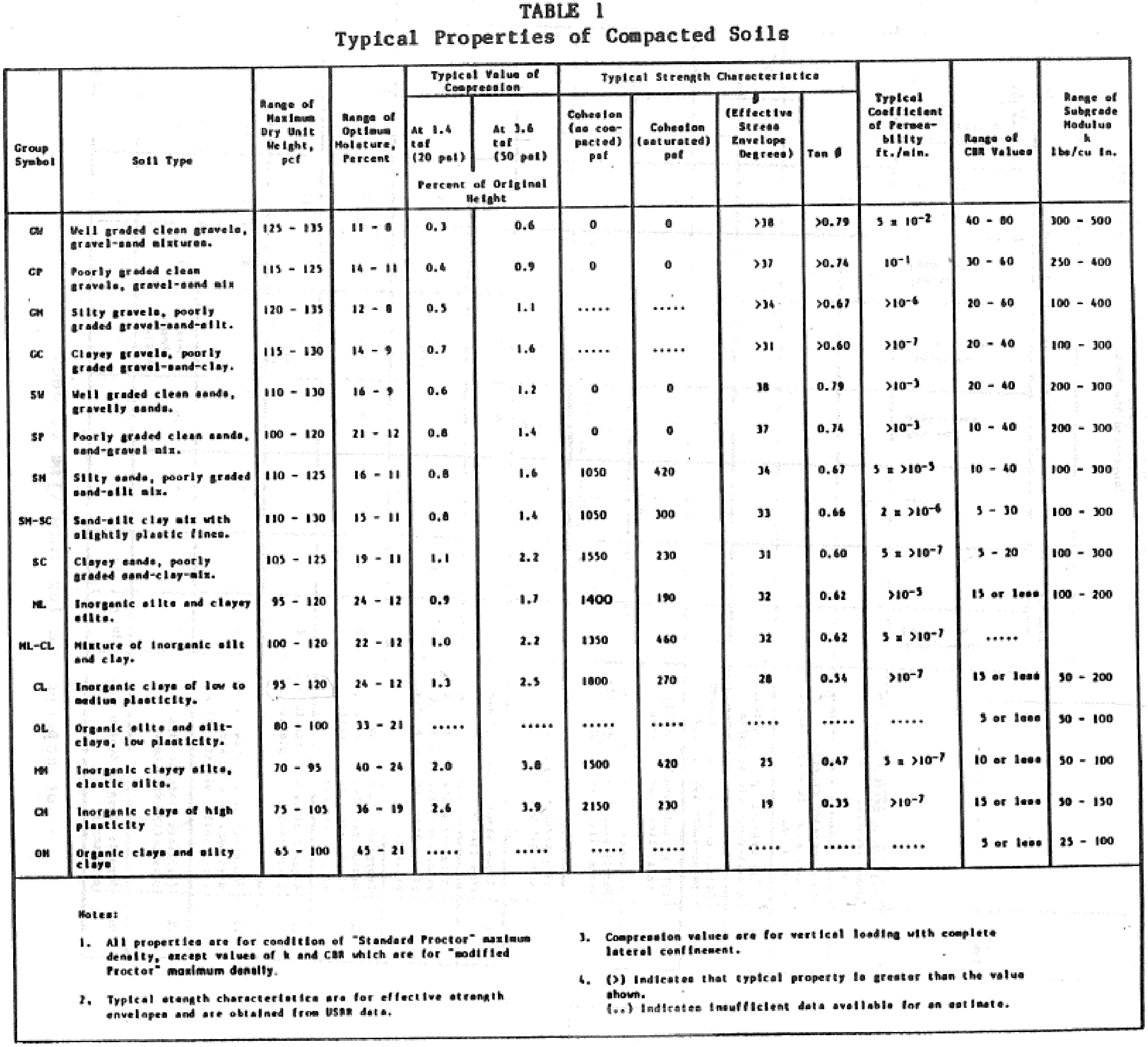


TABLE 1

Typical Properties of Compacted Soils

Group Symbol	Soil Type	Range of Maximum Dry Unit Weight, pcf	Range of Optimum Moisture, Percent	Typical Value of Compression		Typical Strength Characteristics				Typical Coefficient of Permeability ft./min.	Range of CBR Values	Range of Subgrade Modulus k lbs/cu in.
				At 1.4 tsf (20 psi)	At 3.6 tsf (50 psi)	Cohesion (as compacted) psf	Cohesion (saturated) psf	ϕ (Effective Stress Envelope Degrees)	Tan ϕ			
				Percent of Original Height								
GW	Well graded clean gravels, gravel-sand mixtures.	125 - 135	11 - 8	0.3	0.6	0	0	>38	>0.79	5 x 10^{-2}	40 - 80	300 - 500
GP	Poorly graded clean gravels, gravel-sand mix	115 - 125	14 - 11	0.4	0.9	0	0	>37	>0.74	10^{-1}	30 - 60	250 - 400
GM	Silty gravels, poorly graded gravel-sand-silt.	120 - 135	12 - 8	0.5	1.1	.....	.....	>34	>0.67	>10^{-6}	20 - 60	100 - 400
GC	Clayey gravels, poorly graded gravel-sand-clay.	115 - 130	14 - 9	0.7	1.6	.....	.....	>31	>0.60	>10^{-7}	20 - 40	100 - 300
SW	Well graded clean sands, gravelly sands.	110 - 130	16 - 9	0.6	1.2	0	0	38	0.79	>10^{-3}	20 - 40	200 - 300
SP	Poorly graded clean sands, sand-gravel mix.	100 - 120	21 - 12	0.8	1.4	0	0	37	0.74	>10^{-3}	10 - 40	200 - 300
SM	Silty sands, poorly graded sand-silt mix.	110 - 125	16 - 11	0.8	1.6	1050	420	34	0.67	5 x >10^{-5}	10 - 40	100 - 300
SM-SC	Sand-silt clay mix with slightly plastic fines.	110 - 130	15 - 11	0.8	1.4	1050	300	33	0.66	2 x >10^{-6}	5 - 30	100 - 300
SC	Clayey sands, poorly graded sand-clay-mix.	105 - 125	19 - 11	1.1	2.2	1550	230	31	0.60	5 x >10^{-7}	5 - 20	100 - 300
ML	Inorganic silts and clayey silts.	95 - 120	24 - 12	0.9	1.7	1400	190	32	0.62	>10^{-5}	15 or less	100 - 200
ML-CL	Mixture of inorganic silt and clay.	100 - 120	22 - 12	1.0	2.2	1350	460	32	0.62	5 x >10^{-7}	.....	
CL	Inorganic clays of low to medium plasticity.	95 - 120	24 - 12	1.3	2.5	1800	270	28	0.54	>10^{-7}	15 or less	50 - 200
OL	Organic silts and silt-clays, low plasticity.	80 - 100	33 - 21	.....	.....	.....	.....	.....	.....	.....	5 or less	50 - 100
MH	Inorganic clayey silts, elastic silts.	70 - 95	40 - 24	2.0	3.8	1500	420	25	0.47	5 x >10^{-7}	10 or less	50 - 100
CH	Inorganic clays of high plasticity	75 - 105	36 - 19	2.6	3.9	2150	230	19	0.35	>10^{-7}	15 or less	50 - 150
OH	Organic clays and silty clays	65 - 100	45 - 21	.....	.....	.....	.....	.....	.....	.....	5 or less	25 - 100

Notes:

1. All properties are for condition of "Standard Proctor" maximum density, except values of k and CBR which are for "modified Proctor" maximum density.

2. Typical strength characteristics are for effective strength envelopes and are obtained from USBR data.

3. Compression values are for vertical loading with complete lateral confinement.

4. (>) Indicates that typical property is greater than the value shown.
(..) Indicates insufficient data available for an estimate.

Client:	Santa Clara Valley Water District	**Prepared By:**	T. Haynes/ Len Sansone
Project:	Lower Llagas Creek Capacity Restoration Capital Project	**Date:**	5/15/12
Project No.:	11540-0	**Checked By:**	L. Sansone
		Date:	6/1/2012

Seepage Parameters

The 2011 Guidance Document for Geotechnical Analyses: Urban Levee Geotechnical Evaluations Program, Revision 10, Department of Water Resources permeability presents ranges for various soil types. The published permeability ranges are shown graphically on **Attachment 1-1**, Published Permeability Values. For comparison purposes, this figure also includes the selected horizontal permeability (k_h) values assigned to the analyses for soil types described Appendix E.

Permeability Based on Grain Size Distribution of Granular Soils (Coarse Grained Alluvium)

GEI reviewed particle size distribution curves developed from sieve analyses of granular materials obtained from site explorations. The grain size data from these curves was applied to empirical correlations (Chapuis and Aubertin 2003 and ASDSO 2010) to develop permeability estimates of the granular materials. A list of the equations for each method used to estimate permeability and a summary of the permeability estimates of the various granular foundation materials as determined by the empirical correlations are shown in Attachment 1-2.

Hydraulic Conductivity Test of Levee Fill

Cooper Testing Laboratories performed a hydraulic conductivity test on one Shelby Tube specimen of Levee Fill soil recompacted to 92% of the maximum dry density. The material was classified as a fat clay (CH), according to the USCS, and the vertical hydraulic conductivity from the laboratory test is 2.00E-07 cm/sec.

Permeabilities of Peat Soils

The permeability of the peat soil layer was determined by reviewing vertical hydraulic conductivity test data from peat materials from the Twitchell Island Levees in the San Joaquin Delta, as presented in a GEI Geotechnical Investigation and Evaluation Report (GEI 2009). Typical values reported in the paper titled, “ Engineering Properties of Fibrous Peats (Mesri and Ajlouni, Journal of Geotechnical and Geoenvironmental Engineering, July 2007) were also reviewed.

Peat soil vertical permeabilities range from $1\text{x}10^{-4}$ cm/sec to $1\text{ x}10^{-7}$ cm/sec depending on void ratio, size and shape of flow channels parallel or perpendicular to the direction of flow. Due to the highly compressible nature of peat soils, the more consolidated the peat becomes the less hydraulically conductive it is. Therefore, the peat soils beneath the levee prism were assigned a lower overall permeability than the less consolidated peat materials outside of the levee prism.

Ratio of Horizontal Permeability (k_h) to Vertical Permeability (k_v)

In general, the anisotropic ratio (k_h/k_v) for most levee and foundation materials ranges from 1 to 4, with granular materials trending towards a value of 1 to 2 and silts and clays trending towards a value of 2 to 4 (URS, 2011). For the Llagas Creek evaluation, an anisotropy ratio of 1 was selected for the granular soils and an anisotropy ratio of 4 was selected for the silts and clays. The typical range for anisotropy of fibrous peats is 3 to 5 (Journal of Geotechnical and Geoenvironmental Engineering, July 2007), is approximately 3 to 5. An anisotropy ratio of 4 was assigned to the peat layers.

Selected Permeability Values

A summary of selected permeability and k-ratio values for all soil layers is presented on **Table E-1**.

Seepage Parameters

Unsaturated Soil Properties

SEEP/W considers flow of water through both partially saturated and saturated soil. In SEEP/W we defined hydraulic conductivity as a function of soil suction (negative pore pressures) for soils that may become partially saturated in the model. We modeled unsaturated soil properties using SEEP/W's built-in volumetric water content (VWC) functions, which are based on soil gradation. We used these curves to estimate hydraulic conductivity (K) functions (hydraulic conductivity versus suction) for each soil type using the following procedure.

1. We used SEEP/W to generate a VWC function based on a saturated volumetric water content (i.e. porosity), which were based on typical ranges for the soil types, and on the selection of one of the seven built-in functions. SEEP/W then generated the VWC.
2. We used SEEP/W to generate a K-function based on the VWC function. The generation of the K-function is based on the method proposed by Van Genuchten (1980), which estimates points of the K-function based on the shape of the VWC function. The required input parameters are saturated hydraulic conductivity and residual volumetric water content. The saturated hydraulic conductivities are listed in the previous table. We estimated that the residual volumetric water content for each soil was 10% of the saturated volumetric water content.

The input parameters that we used for each soil type are listed in the table below.

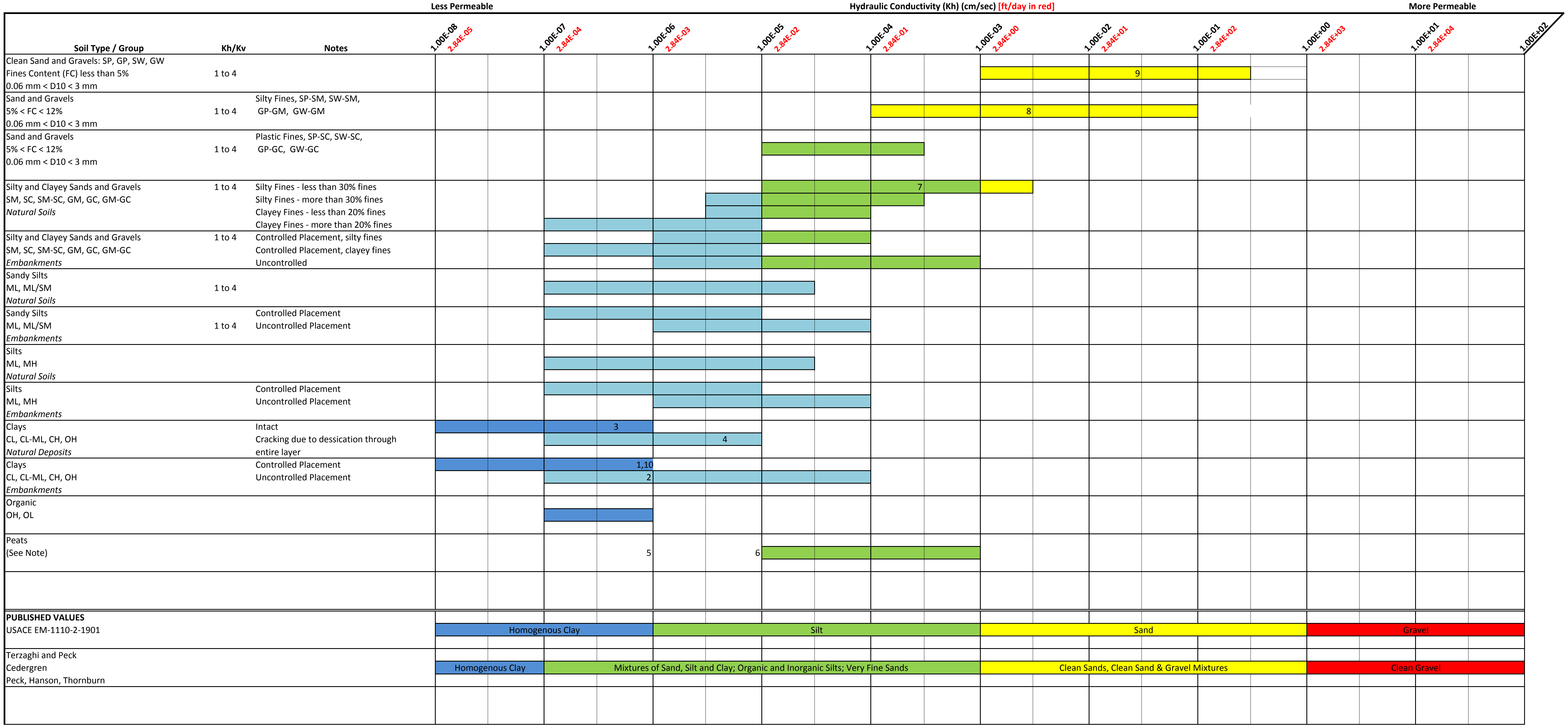
Soil Layer	Built-in function used	Saturated volumetric water content	Residual volumetric water content
Levee Fill	Clay	0.35	0.035
Loose Levee Fill	Clay	0.35	0.035
Softer Fine Grained Alluvium	Clay	0.35	0.035
Stiffer Fine Grained Alluvium	Silty Clay	0.30	0.030
Coarse Grained Alluvium > 12% Fines	Silty Sand	0.25	0.025

Attachments:

Attachment 1-1	Hydraulic Conductivity Values from DWR Workshop – October 27, 2010
Attachment 1-2	Empirical Correlations and Estimates for Permeability of Coarse Grained Soils

Attachment 1-1
Hydraulic Conductivity Values from DWR Workshop

DWR Levee Evaluations
Hydraulic Conductivity Values from DWR Workshop - October 27, 2010



Soil Type / Group	Kh/Kv	Notes
Clean Sand and Gravels: SP, GP, SW, GW Fines Content (FC) less than 5% 0.06 mm < D10 < 3 mm	1 to 4	
Sand and Gravels 5% < FC < 12% 0.06 mm < D10 < 3 mm	1 to 4	Silty Fines, SP-SM, SW-SM, GP-GM, GW-GM
Sand and Gravels 5% < FC < 12% 0.06 mm < D10 < 3 mm	1 to 4	Plastic Fines, SP-SC, SW-SC, GP-GC, GW-GC
Silty and Clayey Sands and Gravels SM, SC, SM-SC, GM, GC, GM-GC *Natural Soils*	1 to 4	Silty Fines - less than 30% fines Silty Fines - more than 30% fines Clayey Fines - less than 20% fines Clayey Fines - more than 20% fines
Silty and Clayey Sands and Gravels SM, SC, SM-SC, GM, GC, GM-GC *Embankments*	1 to 4	Controlled Placement, silty fines Controlled Placement, clayey fines Uncontrolled
Sandy Silts ML, ML/SM *Natural Soils*	1 to 4	
Sandy Silts ML, ML/SM *Embankments*	1 to 4	Controlled Placement Uncontrolled Placement
Silts ML, MH *Natural Soils*		
Silts ML, MH *Embankments*		Controlled Placement Uncontrolled Placement
Clays CL, CL-ML, CH, OH *Natural Deposits*		Intact Cracking due to dessication through entire layer
Clays CL, CL-ML, CH, OH *Embankments*		Controlled Placement Uncontrolled Placement
Organic OH, OL		
Peats (See Note)		
PUBLISHED VALUES USACE EM-1110-2-1901		
Terzaghi and Peck Cedergren Peck, Hanson, Thornburn		

Conversion Factors 1 cm/sec = 2835 ft /day

1 ft/day = 3.53E-04 cm/sec

Soils Used in Analyses
1 Levee Fill
2 Loose Levee Fill
3 Softer Fine Grained Alluvium
4 Stiffer Fine Grained Alluvium
5 Peat Under Levee Prism
6 Peat Over Levee Prism
7 Coarse Grained Alluvium > 12% Fines
8 Coarse Grained Alluvium <5% Fines < 12%
9 Coarse Grained Alluvium < 5% Fines
10 Artificial Fill

Note: The permeability ranges selected for the Peats were lower than the DWR published values due to the relatively high confinement and relatively high clay content at the Lower Llagas Creek project area

Attachment 1-2
Empirical Correlations for Permeability of Coarse Grained Soils

GEI Consultants

Client: Santa Clara Valley Water District
Project: Lower Llagas Creek Capacity Restoration Capital Project
Project No.: 11540-0

Prepared By: T. Haynes
Date: 5/15/2012
Checked By: Len Sansone
Date:

Empirical Correlations for Permeability of Coarse Grained Soils

Kozeny-Carman (Chapuis and Aubertin 2003)

$$\log k = A + \log\left[\frac{e^3}{D_R^2 S^2 (1+e)}\right]$$

k = permeability
D_R = specific weight of solids
S = specific surface
e = void ratio

Applicable for any natural homogeneous soil.

Kozeny-Carman (Carrier 2003)

$$k = 1.99 \times 10^4 \left(100\% \Big/ \left\{\Sigma\left[f_i / (D_{li}^{0.404} \times D_{si}^{0.595})\right]\right\}\right)^2 \times (1/SF^2) \times [e^3 / (1 + e)]$$

k = permeability
f_i = fraction of particles between two sieve sizes
D_{li} = particle size from the larger sieve
D_{si} = particle size from the smaller sieve
SF = shape factor
e = void ratio

Applicable for relatively compact coarse sands to non-plastic silts.

Lincoln Average (Sherard et al 1984)

$$k = 0.35 \times D_{15}^2$$

k = permeability
D_{15} = particle-size diameter corresponding to 15% passing on the grain size distribution curve.

Applicable for clean sand and gravel filters with D_{15} size between 0.12 and 10 mm.

Hazen's Method (Hazen 1892, 1911)

$$k = C \times D_{10}^2$$

k = permeability
C = Hazen empirical coefficient
D_{10} = particle-size diameter corresponding to 10% passing on the grain size distribution curve.

Applicable for loose soils with D_{10} size between 0.1 and 3 mm.

GEI Consultants

Client: Santa Clara Valley Water District
Project: Lower Llagas Creek Capacity Restoration Capital Project
Project No.: 11540-0

Prepared By: T. Haynes
Date: 5/15/2012
Checked By: Len Sansone
Date:

Empirical Correlations for Permeability of Coarse Grained Soils

Chapuis Method (Chapuis 2004)

$$k = 2.4622 \text{ x } \left[D_{10}^{2} \text{ x } \frac{e^{3}}{(1+e)} \right]^{0.7825}$$

k = permeability
D_{10} = particle-size diameter corresponding to 10% passing on the grain size distribution curve.
e = void ratio

Applicable for loose soils with D_{10} size between 0.1 and 3 mm.

Slichter Estimate (Slichter 1905)

$$k = 0.01047 \text{ x } e^{9.3071 \text{ x } n} D_{10}^{2}$$

k = permeability
e = void ratio
D_{10} = particle-size diameter corresponding to 10% passing on the grain size distribution curve.

Applicable for soils with D_{10} values between 0.01 and 5 mm.

EMPIRICAL ESTIMATES FOR PERMEABILITY OF COARSE GRAINED SOILS

											Hydraulic Conductivity (cm/sec)						
Boring	Depth	Elevation	Soil Description (USCS)	% Gravel	% Sand	% Fines	Field Blow Counts	D_{10}	D_{15}	Avg. Void Ratio	Chapuis Aubertin KC	Carrier KC	Lincoln Average	Hazen	Chapuis	Slichter	Notes
B-132+00W	34	138	Poorly Graded SAND with Gravel (SP)	14.9	83.3	1.8	50/6"	0.620	0.800	0.287	8.30E-02	8.00E-02	2.24E-01	4.61E-02	5.46E-02	3.03E-02	
B-132+50E	39	136	Well Graded SAND (SW)	10.3	86.1	3.6	24	0.300	0.430	0.394	6.50E-02	3.90E-02	6.47E-02	1.08E-02	3.42E-02	1.24E-02	
B-050+00W	49	105	Poorly Graded SAND (SP)	4.8	91.2	4.0	64	0.230	0.300	0.307	6.30E-03	7.80E-03	3.15E-02	5.29E-03	1.25E-02	4.93E-03	
B-173+50W	34	151	Well Graded SAND with Silt and Gravel (SW-SM)	33.6	61.9	4.5	55	0.300	0.500	0.338	1.60E-02	2.70E-02	8.75E-02	1.08E-02	2.49E-02	9.38E-03	
B-065+00E	45.5	112.5	Well Graded GRAVEL with Sand (GW)	56.1	39.2	4.7	50/6"	0.270	0.400	0.317	2.20E-02	1.80E-02	5.60E-02	1.09E-02	1.84E-02	6.80E-03	Mod Cal
B-127+00W	29	142	Poorly Graded SAND with Silt (SP-SM)	12.0	82.7	5.3	55	0.400	0.650	0.338	8.20E-03	1.40E-02	1.48E-01	1.92E-02	3.90E-02	1.67E-02	Mod Cal
B-166+50E	35	147	Well Graded SAND with Silt and Gravel (SW-SM)	30.5	63.3	6.2	49	0.180	0.300	0.338	9.30E-03	9.80E-03		3.89E-03	1.12E-02	3.38E-03	
B-132+00W	25	147	Poorly Graded SAND with Silt and Gravel (SP-SM)	19.2	73.8	7.0	34	0.150	0.250	0.467	9.40E-03	2.20E-03		2.70E-03	1.65E-02	4.35E-03	Mod Cal
B-141+00W	29.5	143.5	Poorly Graded GRAVEL with Silt and Sand (GP-GM)	51.3	41.6	7.1	50/6"	0.170	0.330	0.258	4.90E-03	4.10E-03		4.34E-03	5.76E-03	1.92E-03	Mod Cal
B-092+50W	30	134	Well Graded SAND with Silt and Gravel (SW-SM)	45.5	46.5	8.0	29	0.130	0.320	0.382	7.10E-03	1.00E-02		2.03E-03	8.66E-03	2.21E-03	Mod Cal
B-148+00E	30	145	Poorly Graded GRAVEL with Silt and Sand (GP-GM)	56.0	35.8	8.2	66	0.120	0.400	0.287	4.30E-03	4.80E-03		1.73E-03	4.18E-03	1.13E-03	
B-078+00W	39	125	Well Graded SAND with Silt and Gravel (SW-SM)	32.7	58.8	8.5	65	0.120	0.300	0.338	3.10E-03	5.70E-03		1.73E-03	5.92E-03	1.50E-03	
B-132+50E	29.5	145.5	Poorly Graded SAND with Silt and Gravel (SP-SM)	19.9	71.2	8.9	47	0.110	0.430	0.338	4.40E-03	5.10E-03		1.45E-03	5.17E-03	1.26E-03	Mod Cal
B-107+00W	24	142	Well Graded SAND with Clay and Gravel (SW-SC)	34.1	56.7	9.2	66	0.090	0.250	0.338	2.90E-03	4.70E-03				8.45E-04	
B-059+00W	44	111	Poorly Graded SAND with Silt and Gravel (SP-SM)	36.6	53.2	10.2	50/6"	0.075	0.240	0.333	5.80E-04	1.20E-03				5.87E-04	
B-173+50W	25	160	Poorly Graded SAND with Silt and Gravel (SP-SM)	22.0	66.9	11.1	36	0.060	0.230	0.418	1.60E-03	3.10E-03				5.56E-04	Mod Cal
B-141+00W	24	149	Poorly Graded SAND with Silt and Gravel (SP-SM)	27.4	61.2	11.4	45	0.060	0.200	0.394	1.60E-03	2.80E-03				4.97E-04	
B-127+00W	25	146	Poorly Graded GRAVEL with Clay and Sand (GP-GC)	46.0	41.1	12.9	28	0.040	0.105	0.258	1.50E-03	7.00E-04				1.07E-04	Mod Cal
B-141+00W	5.5	167.5	Poorly Graded GRAVEL with Sand (GP)	6.9	75.3	17.8	10	0.020	0.050	0.454	1.00E-03	6.20E-04				7.31E-05	Mod Cal
B-173+50W	6	179	Silty SAND (SM)	0.3	79.7	20.0	14	0.030	0.050	0.858	2.10E-03	6.40E-03				6.68E-04	Mod Cal
B-141+00W	3	170	Clayey SAND with Gravel (SC)	24.8	54.9	20.3	18	0.020	0.050	0.454	8.20E-04	4.70E-04				7.31E-05	
B-092+50E	9	141	Silty SAND with Gravel (SM)	14.8	63.0	22.2		0.014	0.031	0.430	8.70E-05	1.60E-04				3.20E-05	Shelby Tube
B-078+00W	29	135	Silty SAND (SM)	1.0	76.0	23.0	19	0.012	0.027	0.454	1.50E-04	1.50E-04				2.63E-05	
B-107+00W	20	146	Silty SAND (SM)	6.0	60.7	33.3	15	0.009	0.020	0.535	2.90E-04	2.80E-04				1.02E-04	Mod Cal
B-166+50E	6.5	175.5	Silty SAND (SM)	0.1	58.0	41.9	10	0.020	0.030	0.571	1.30E-04	2.80E-04				1.28E-04	

Modcal blow count multiplied by 0.65 to obtain Field Blow Count

Appendix F

Stability Analyses

Client:	Santa Clara Valley Water District	**Prepared By:**	Len Sansone /Tim Haynes
Project:	Lower Llagas Creek Capacity Restoration Capital Project	**Date:**	05/17/ 2012
Project No.:	11540-0	**Checked By:**	Len Sansone
		Date:	6/1/2012

Static Slope Stability Analysis

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Attachments

Attachment 1 – Fine Grained Shear Strengths
Attachment 2 – Peat Shear Strengths
Attachment 3 – Coarse Grained Shear Strengths

Slope Stability Approach:

Slope stability was evaluated in general accordance with Corps' Engineer Manual EM 1110-2-1913, *Design and Construction of Levees* dated April 2000.

Static slope stability analyses were performed for the following cases:

- Steady-State Seepage
- Rapid Drawdown
- End-of-Construction (for feasibility of freeboard alternatives being considered for design)

Steady-State Stability

Analyses Approach and Material Properties

The steady-state stability case assumes steady-state flow conditions exist within the levee embankment and foundation. The phreatic surface and pore water pressures are obtained from the seepage analyses described in Appendix E. Because steady-state seepage is a long term condition, GEI assigned effective (i.e. drained) strengths to all soils. As specified in USACE EM 1110-2-1913, the required minimum factor of safety for this case is 1.4.

The steady-state stability analyses were performed using SLOPE/W software by GEO-Slope International, Ltd. Stability was evaluated using the Morgenstern-Price Analysis method, which satisfies both moment and force equilibrium. Slip surface geometries were defined using the grid and radius method.

The steady-state stability analyses were performed only for designated sections along Llagas Creek where levee embankments are present, and where the design water surface could be impounded against the levee embankment and potentially develop a steady-state seepage condition. Analyses Stations 126+00 West, 134+00 East and West, and 166+50 East and West were not modeled for steady-state stability because these sections are located in channelized sections of Reaches 2A and 2B of Llagas Creek where levee embankment protection for the design water surface is not necessary.

The unit weights of various material types were determined by evaluating in-situ dry density and moisture content data from samples obtained during the subsurface exploration program. **Tables F-1** through **F-5** summarize material unit weights, as well as strength parameters, assigned for the various material types modeled in the steady-state stability analyses.

Slope Stability Analysis under Rapid Drawdown Conditions

Analyses Approach

The rapid drawdown case is based on the assumption that an embankment or slope is saturated long enough under the design water surface (i.e. flood) condition to develop steady-state seepage conditions, and the flood recedes quicker than pore pressures dissipate in the clay embankment or slope and fine-grained alluvial foundation soils. Shear strengths for these fine grained materials are defined with drained (effective) strength parameters under the initial steady-state condition with the design water surface, and undrained (total) strength parameters after the water recedes allowing the development of pore pressures in the fine grained soils.

For the three-stage rapid drawdown analyses, a separate slope stability computation is performed at each stage as follows, and the lowest computed factor of safety is reported:

- For low-permeability materials; (1) effective stresses (drained strengths) are used with the first phreatic surface before drawdown, (2) total stresses (undrained strengths) are used for the second phreatic surface after drawdown (3) the lower of the two strengths (drained or undrained) is used with the second phreatic surface.
- For free draining materials, effective stresses (drained conditions) are used for all three stages.

The shear strength parameters assigned for the rapid drawdown analyses are shown in **Tables F-1** through **F-7.**

The rapid drawdown analyses were performed on the waterside slope of the levee. In the case of the Llagas Creek project, the creek is channelized at the north end of Reach 2A (Section 126+00 West) and throughout Reach 2B (Sections 134+00 and 166+50 east and west). For analysis sections at these locations, a rapid drawdown analysis was performed to check the stability of the channel slope on the waterside to see if there is the potential for channel slumping under drawdown conditions that could impact the creek.

GEI performed the rapid drawdown analysis of the waterside slope using the SLOPE/W program with similar search methods as the steady-state stability analysis. For Stations 50+00 and 78+00, the slip surfaces were determined using the block-specified method where noted in **Tables F-1** and **F-2**, since a block failure surface through the peat layer was determined to be the critical case for these sections.

For the first stage of the rapid drawdown analysis, a phreatic surface generated by the SEEP/W steady-state seepage analysis at the design water surface was used to model the flood pore water pressure in the embankment or channel slope. The post-drawdown pore water pressures were modeled with a horizontal phreatic surface at the drawdown level of the creek. This drawdown level as presented in **Tables F-1** through **F-7** is assumed to be a typical flow elevation in the creek channel under non-flood conditions.

Slope Stability Analysis - End of Construction Conditions

Analyses Approach and Material Properties

The end-of-construction stability case assumes that excess pore pressures have not dissipated within the levee embankment and cohesive foundation soils. A phreatic surface was not specified since the model was analyzed using total stresses. Because excess pore pressures exist in the cohesive soils, GEI assigned total (i.e. undrained) strengths, where the friction angle equals zero, to cohesive soils and effective (i.e. drained) strengths to cohesionless soils. As specified in USACE EM 1110-2-1913, the required minimum factor of safety for this case is 1.3.

The end-of-construction stability analyses were performed using SLOPE/W software by GEO-Slope International, Ltd. Stability was evaluated using the Morgenstern-Price Analysis method, which satisfies both moment and force equilibrium. Slip surface geometries were defined using the grid and radius method.

The end-of-construction stability analyses were performed for the section at Station 50+00. This section location has the largest freeboad deficiency and has softer peat and clay layers with lower shear strengths. Two options for remediating the freeboard deficiency, a fill and a wall, were modeled. The fill was modeled assuming a 3H:1V waterside slope from the existing waterside hinge to the required crest elevation, a crest width of 15 feet, and a 2H:1V landside slope. The strength parameters for the fill are discussed in Attachment 1. The wall was modeled as a 5 foot wide surcharge load of 150 pcf on the existing levee crest to the required elevation.

The unit weights of various material types were determined by evaluating in-situ dry density and moisture content data from samples obtained during the subsurface exploration program. **Table F-1** summarizes material unit weights, as well as strength parameters, assigned for the various material types modeled in the end-of-construction stability analyses.

GEI Consultants

Client: Santa Clara Valley Water District
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Project No.: 11540-0
Prepared By: Len Sansone /Tim Haynes
Date: 05/17/ 2012
Checked By: Len Sansone
Date: 6/1/2012

Static Slope Stability Analysis

Approach to Estimating Shear Strengths:

The general approach used to evaluate shear strengths for the embankment and foundation soils is summarized below. Specific shear strength information used for analysis is presented in Attachment 1 for the fine grained soils, Attachment 2 for the peats, and Attachment 3 for coarse grained soils.

Drained shear strengths for fine grained soils, peats, and coarse grained soils were estimated from several sources of data including:

- Empirical Correlations to Plasticity Index (PI)
- Empirical Correlations to SPT N - Values
- Consolidated Undrained (CU) Triaxial Tests with pore pressure measurements

The material types for the cross sections that were considered by GEI for the steady-state stability analyses are similar to those assigned for the steady-state seepage analyses described in Appendix E. The empirical correlations of drained shear strengths to SPT N- Values were considered in the assignment of shear strength parameters to the coarse grained soils. The empirical correlations to PI and the site specific CU triaxial tests with pore pressure measurements were used to assign drained shear strength parameters to the levee fill and fine-grained alluvium soils. A summary of assigned drained strength parameters for the analyzed cross sections is presented on **Tables F-1 through F-7**

For rapid drawdown analyses, the undrained strength parameters for the fine grained materials were determined from empirical correlations, vane shear test data on foundation soils performed previously by the USDA in 1973, and undrained strength tests of on-site soils samples from the recent subsurface exploration program. The recent undrained strength testing includes Triaxial CU tests, Unconsolidated Undrained (UU) Triaxial tests, and Unconfined Compression tests. The undrained strength data was used to develop an undrained strength envelope for input into a three-stage rapid drawdown procedure developed by Duncan and Wright.

For End-of-Construction conditions, the undrained strength parameters for the fine grained materials were determined from empirical correlations, vane shear test data on foundation soils performed previously by the USDA in 1973, and undrained strength tests of on-site soils samples from the recent subsurface exploration program. The recent undrained strength testing includes Triaxial CU tests, Unconsolidated Undrained (UU) Triaxial tests, and Unconfined Compression tests). The undrained strength values for End-of-Construction stability are expressed in terms of total stresses (i.e. horizontal strength envelope with a cohesion intercept, c = constant and $\varphi = 0°$)

Stability Analysis Results

GEI used the SLOPE/W program to model deeper failure surfaces for a given cross section that may compromise the levee crown and would be considered a levee safety issue. The results of the static slope stability analyses are presented in **Tables F-1 through F-7**.

The minimum factor of safety for steady-state stability analyses within the analyzed sections is 1.6, which exceeds the USACE minimum factor of safety criterion of 1.4. The minimum factor of safety for rapid drawdown failure is 1.1, which equals the USACE minimum factor of safety criterion of 1.1. The minimum factor of safety for end of construction conditions is 2.6, which exceeds the USACE minimum factor of safety criterion of 1.3.

References

Duncan M.J. and Wright, S.G., 2005, Soil Strength and Slope Stability, John Wiley & Sons, Inc., Hoboken, New Jersey.

Geo-Slope International, Ltd. 2007. Stability Modeling with SLOPE/W 2007. 2nd Edition.

U.S. Army Corps of Engineers, 2000, Design and Construction of Levees, Engineer Manual EM 1110-2-1913, April 30.

U.S. Army Corps of Engineers, 2003, Slope Stability, Engineer Manual EM 1110-2-1902, October 31.

TABLE F-1
SUMMARY OF SLOPE STABILITY ANALYSES - STA 50+00 (REACH 1)

				Model Parameters							Min. Required Factor of Safety		
					Strength Parameters					Unit Weight			
Section	**Case**	**Analyzed Slope**	**Water Surface**	Layers	c'	phi'	c	phi		(pcf)		**Calculated Factor of Safety**	Notes
Station 50+00 West	Steady-State Seepage	Landside 3.3H:1V slope	Design Water Surface Elevation 154.8* (overtop)	**Levee Fill**	200	27	-	-	-	115	1.4	1.94	Drained Strength Parameters
				Loose Levee Fill	50	27	-	-	-	110			
				Softer Fine Grained Alluvium- CH (Fat Clays)	70	27	-	-	-	110		Block-specified	
				Peat- PT	0	30	-	-	-	70			
				Peat Under Levee- PT	0	30	-	-	-	70			
				Softer Fine Grained Alluvium- CH (Fat Clays)	70	27	-	-	-	110			
				Stiffer Fine Grained Alluvium- Lean to Fat Clays (CL/CH)	200	30	-	-	-	120			
				Clean Coarse Grained Alluvium- Dense Poorly Graded Sands/ Gravel with Sands (GP/SP)	0	35	-	-	-	140			
				Stiffer Fine Grained Alluvium - Lean Clays (CL)	200	30	-	-	-	120			
Station 50+00 East	Steady-State Seepage	Landside 2.2H:1V slope	Design Water Surface Elevation 154.8* (overtop)	**Levee Fill**	200	27	-	-	-	115	1.4	1.45	Drained Strength Parameters
				Loose Levee Fill	50	27	-	-	-	110			
				Softer Fine Grained Alluvium- CH (Fat Clays)	70	27	-	-	-	110		Block-specified	
				Peat- PT	0	30	-	-	-	70			
				Peat Under Levee- PT	0	30	-	-	-	70			
				Softer Fine Grained Alluvium- CH (Fat Clays)	70	27	-	-	-	110			
				Stiffer Fine Grained Alluvium- Lean to Fat Clays (CL/CH)	200	30	-	-	-	120			
				Clean Coarse Grained Alluvium- Dense Poorly Graded Sands/ Gravel with Sands (GP/SP)	0	35	-	-	-	140			
				Stiffer Fine Grained Alluvium - Lean Clays (CL)	200	30	-	-	-	120			
Station 50+00 West	Rapid Drawdown	Waterside 2.5H:1V slope	Design Water Surface Elevation 154.8* (overtop) drops to Water level in channel under normal winter conditions, El. 142	**Levee Fill**	200	27	1000	15	-	115	1.0	1.46	Cohesive Soils: First Stage of analyses- Use effective stress envelopes. Second Stage Analyses- Use undrained shear strength values
				Loose Levee Fill	50	27	500	15	-	110			
				Softer Fine Grained Alluvium- CH (Fat Clays)	70	27	100	17	-	110		Block-specified	
				Peat- PT	0	30	0	17	-	70			
				Peat Under Levee- PT	0	30	0	17	-	70			
				Softer Fine Grained Alluvium- CH (Fat Clays)	70	27	100	17	-	110			
				Stiffer Fine Grained Alluvium- Lean to Fat Clays (CL/CH)	200	30	400	17	-	120			
				Clean Coarse Grained Alluvium- Dense Poorly Graded Sands/ Gravel with Sands (GP/SP)	0	35	0	35	-	140			
				Stiffer Fine Grained Alluvium - Lean Clays (CL)	200	30	400	17	-	120			Granular Soils - Use Drained (Effective)- Strength Parameters
Station 50+00 East	Rapid Drawdown	Waterside 2.7H:1V slope	Design Water Surface Elevation 154.8* (overtop) drops to Water level in channel under normal winter conditions, El. 142	**Levee Fill**	200	27	1000	15	-	115	1.0	1.39	Cohesive Soils: First Stage of analyses- Use effective stress envelopes. Second Stage Analyses- Use undrained shear strength values
				Loose Levee Fill	50	27	500	15	-	110			
				Softer Fine Grained Alluvium- CH (Fat Clays)	70	27	100	17	-	110			
				Peat- PT	0	30	0	17	-	70			
				Peat Under Levee- PT	0	30	0	17	-	70			
				Softer Fine Grained Alluvium- CH (Fat Clays)	70	27	100	17	-	110			
				Stiffer Fine Grained Alluvium- Lean to Fat Clays (CL/CH)	200	30	400	17	-	120			
				Clean Coarse Grained Alluvium- Dense Poorly Graded Sands/ Gravel with Sands (GP/SP)	0	35	0	35	-	140			
				Stiffer Fine Grained Alluvium - Lean Clays (CL)	200	30	400	17	-	120			Granular Soils - Use Drained (Effective)- Strength Parameters

TABLE F-1
SUMMARY OF SLOPE STABILITY ANALYSES - STA 50+00 (REACH 1)

Section	Case	Analyzed Slope	Water Surface	Model Parameters							Min. Required Factor of Safety	Calculated Factor of Safety	Notes
					Strength Parameters					Unit Weight (pcf)			
				Layers	c'	phi'	c	phi					
Station 50+00 West	End-of-Construction (New Levee Fill)	Landside	Winter Water Surface Elevation 142.0	**Levee Fill**	-	-	-	-	1450	115	1.3	3.02	Undrained Strength Parameters for Cohesive Soils
		2.2H:1V slope		**New Levee Fill**	-	-	-	-	1450	120			
				Softer Fine Grained Alluvium- CH (Fat Clays)	-	-	-	-	750	110			Drained Strength Parameters for Cohesionless Soils
				Peat- PT	-	-	-	-	500	70			
				Peat Under Levee- PT	-	-	-	-	500	70			
				Softer Fine Grained Alluvium- CH (Fat Clays)	-	-	-	-	1000	110			
				Stiffer Fine Grained Alluvium- Lean to Fat Clays (CL/CH)	-	-	-	-	1500	120			
				Clean Coarse Grained Alluvium- Dense Poorly Graded Sands/ Gravel with Sands (GP/SP)	0	35	-	-	-	140			
				Stiffer Fine Grained Alluvium - Lean Clays (CL)	-	-	-	-	1500	120			
Station 50+00 West	End-of-Construction (New Levee Fill)	Waterside	Winter Water Surface Elevation 142.0	**Levee Fill**	-	-	-	-	1450	115	1.3	2.83	Undrained Strength Parameters for Cohesive Soils
		2.5H:1V slope		**New Levee Fill**	-	-	-	-	1450	120			
				Softer Fine Grained Alluvium- CH (Fat Clays)	-	-	-	-	750	110			Drained Strength Parameters for Cohesionless Soils
				Peat- PT	-	-	-	-	500	70			
				Peat Under Levee- PT	-	-	-	-	500	70			
				Softer Fine Grained Alluvium- CH (Fat Clays)	-	-	-	-	1000	110			
				Stiffer Fine Grained Alluvium- Lean to Fat Clays (CL/CH)	-	-	-	-	1500	120			
				Clean Coarse Grained Alluvium- Dense Poorly Graded Sands/ Gravel with Sands (GP/SP)	0	35	-	-	-	140			
				Stiffer Fine Grained Alluvium - Lean Clays (CL)	-	-	-	-	1500	120			
Station 50+00 East	End-of-Construction (New Levee Fill)	Landside	Winter Water Surface Elevation 142.0	**Levee Fill**	-	-	-	-	1450	115	1.3	2.66	Undrained Strength Parameters for Cohesive Soils
		2.0H:1V slope		**New Levee Fill**	-	-	-	-	1450	120			
				Softer Fine Grained Alluvium- CH (Fat Clays)	-	-	-	-	750	110			Drained Strength Parameters for Cohesionless Soils
				Peat- PT	-	-	-	-	500	70			
				Peat Under Levee- PT	-	-	-	-	500	70			
				Softer Fine Grained Alluvium- CH (Fat Clays)	-	-	-	-	1000	110			
				Stiffer Fine Grained Alluvium- Lean to Fat Clays (CL/CH)	-	-	-	-	1500	120			
				Clean Coarse Grained Alluvium- Dense Poorly Graded Sands/ Gravel with Sands (GP/SP)	0	35	-	-	-	140			
				Stiffer Fine Grained Alluvium - Lean Clays (CL)	-	-	-	-	1500	120			
Station 50+00 East	End-of-Construction (New Levee Fill)	Waterside	Winter Water Surface Elevation 142.0	**Levee Fill**	-	-	-	-	1450	115	1.3	2.80	Undrained Strength Parameters for Cohesive Soils
		2.7H:1V slope		**New Levee Fill**	-	-	-	-	1450	120			
				Softer Fine Grained Alluvium- CH (Fat Clays)	-	-	-	-	750	110			Drained Strength Parameters for Cohesionless Soils
				Peat- PT	-	-	-	-	500	70			
				Peat Under Levee- PT	-	-	-	-	500	70			
				Softer Fine Grained Alluvium- CH (Fat Clays)	-	-	-	-	1000	110			
				Stiffer Fine Grained Alluvium- Lean to Fat Clays (CL/CH)	-	-	-	-	1500	120			
				Clean Coarse Grained Alluvium- Dense Poorly Graded Sands/ Gravel with Sands (GP/SP)	0	35	-	-	-	140			
				Stiffer Fine Grained Alluvium - Lean Clays (CL)	-	-	-	-	1500	120			

TABLE F-1
SUMMARY OF SLOPE STABILITY ANALYSES - STA 50+00 (REACH 1)

				Model Parameters							Min. Required Factor of Safety		
					Strength Parameters					Unit Weight		Calculated	
Section	**Case**	**Analyzed Slope**	**Water Surface**	Layers	c'	phi'	c	phi		(pcf)		**Factor of Safety**	Notes
Station 50+00 West	End-of-Construction (Strip Load)	Landside	Winter Water Surface Elevation 142.0	**Levee Fill**	-	-	-	-	1450	115	1.3	3.68	Undrained Strength Parameters for Cohesive Soils
		2.2H:1V slope		**Loose Levee Fill**	-	-	-	-	850	110			
				Softer Fine Grained Alluvium- CH (Fat Clays)	-	-	-	-	750	110			Drained Strength Parameters for Cohesionless Soils
				Peat- PT	-	-	-	-	500	70			
				Peat Under Levee- PT	-	-	-	-	500	70			
				Softer Fine Grained Alluvium- CH (Fat Clays)	-	-	-	-	1000	110			
				Stiffer Fine Grained Alluvium- Lean to Fat Clays (CL/CH)	-	-	-	-	1500	120			
				Clean Coarse Grained Alluvium- Dense Poorly Graded Sands/ Gravel with Sands (GP/SP)	0	35	-	-	-	140			
				Stiffer Fine Grained Alluvium - Lean Clays (CL)	-	-	-	-	1500	120			
Station 50+00 West	End-of-Construction (Strip Load)	Waterside	Winter Water Surface Elevation 142.0	**Levee Fill**	-	-	-	-	1450	115	1.3	3.21	Undrained Strength Parameters for Cohesive Soils
		2.5H:1V slope		**Loose Levee Fill**	-	-	-	-	850	110			
				Softer Fine Grained Alluvium- CH (Fat Clays)	-	-	-	-	750	110			Drained Strength Parameters for Cohesionless Soils
				Peat- PT	-	-	-	-	500	70			
				Peat Under Levee- PT	-	-	-	-	500	70			
				Softer Fine Grained Alluvium- CH (Fat Clays)	-	-	-	-	1000	110			
				Stiffer Fine Grained Alluvium- Lean to Fat Clays (CL/CH)	-	-	-	-	1500	120			
				Clean Coarse Grained Alluvium- Dense Poorly Graded Sands/ Gravel with Sands (GP/SP)	0	35	-	-	-	140			
				Stiffer Fine Grained Alluvium - Lean Clays (CL)	-	-	-	-	1500	120			
Station 50+00 East	End-of-Construction (Strip Load)	Landside	Winter Water Surface Elevation 142.0	**Levee Fill**	-	-	-	-	1450	115	1.3	3.08	Undrained Strength Parameters for Cohesive Soils
		2.0H:1V slope		**Loose Levee Fill**	-	-	-	-	850	110			
				Softer Fine Grained Alluvium- CH (Fat Clays)	-	-	-	-	750	110			Drained Strength Parameters for Cohesionless Soils
				Peat- PT	-	-	-	-	500	70			
				Peat Under Levee- PT	-	-	-	-	500	70			
				Softer Fine Grained Alluvium- CH (Fat Clays)	-	-	-	-	1000	110			
				Stiffer Fine Grained Alluvium- Lean to Fat Clays (CL/CH)	-	-	-	-	1500	120			
				Clean Coarse Grained Alluvium- Dense Poorly Graded Sands/ Gravel with Sands (GP/SP)	0	35	-	-	-	140			
				Stiffer Fine Grained Alluvium - Lean Clays (CL)	-	-	-	-	1500	120			
Station 50+00 East	End-of-Construction (Strip Load)	Waterside	Winter Water Surface Elevation 142.0	**Levee Fill**	-	-	-	-	1450	115	1.3	3.03	Undrained Strength Parameters for Cohesive Soils
		2.7H:1V slope		**Loose Levee Fill**	-	-	-	-	850	110			
				Softer Fine Grained Alluvium- CH (Fat Clays)	-	-	-	-	750	110			Drained Strength Parameters for Cohesionless Soils
				Peat- PT	-	-	-	-	500	70			
				Peat Under Levee- PT	-	-	-	-	500	70			
				Softer Fine Grained Alluvium- CH (Fat Clays)	-	-	-	-	1000	110			
				Stiffer Fine Grained Alluvium- Lean to Fat Clays (CL/CH)	-	-	-	-	1500	120			
				Clean Coarse Grained Alluvium- Dense Poorly Graded Sands/ Gravel with Sands (GP/SP)	0	35	-	-	-	140			
				Stiffer Fine Grained Alluvium - Lean Clays (CL)	-	-	-	-	1500	120			

*Used a Design Water Surface Elevation of 154.0', the hydraulic top of the East Levee

TABLE F-2
SUMMARY OF SLOPE STABILITY ANALYSES - STA 78+00 (REACH 2A)

				Model Parameters						Min. Required		
					Strength Parameters				Unit Weight	Factor of Safety	**Calculated**	
Section	**Case**	**Analyzed Slope**	**Water Surface**	Layers	c'	phi'	c	phi	(pcf)		**Factor of Safety**	Notes
Station 78+00 West	Steady-State Seepage	Landside	Design Water Surface Elevation 160.4	**Levee Fill**	200	27	-	-	115	1.4	1.79	Drained Strength Parameters
		2.7H:1V slope		**Softer Fine Grained Alluvium Outside Levee**- CH (Fat Clays)	70	27	-	-	110			
				Stiffer Fine Grained Alluvium Under Levee - CL	200	30	-	-	120			
				Peat- PT	0	30	-	-	70			
				Peat Under Levee- PT	0	30	-	-	70			
				Stiffer Fine Grained Alluvium- CH (Fat Clays)	200	30	-	-	120			
				Coarse Grained Alluvium (>12 percent fines) - Loose to Medium Dense Silty Sand Layer Interbedded with Stiff Lean Clays (SM / CL)	0	32	-	-	120			
				Coarse Grained Alluvium (5 to 12 percent fines) -Medium Dense to Dense Poorly Graded/ Silty Sands (SP/SM)	0	35	-	-	140			
				Stiffer Fine Grained Alluvium - Stiff Lean Clays (CL)	200	30	-	-	120			
Station 78+00 East	Steady-State Seepage	Landside	Design Water Surface Elevation 160.4	**Levee Fill**	200	27	-	-	115	1.4	1.62	
		2.2H:1V slope		**Softer Fine Grained Alluvium Outside Levee** - CH (Fat Clays)	70	27	-	-	110			
				Stiffer Fine Grained Alluvium Under Levee - CL	200	30	-	-	120			
				Peat- PT	0	30	-	-	70			
				Peat Under Levee- PT	0	30	-	-	70			
				Stiffer Fine Grained Alluvium- CH (Fat Clays)	200	30	-	-	120			
				Coarse Grained Alluvium (>12 percent fines) - Loose to Medium Dense Silty Sand Layer Interbedded with Stiff Lean Clays (SM / CL)	0	32	-	-	120			
				Coarse Grained Alluvium (5 to 12 percent fines) -Medium Dense to Dense Poorly Graded/ Silty Sands (SP/SM)	0	35	-	-	140			
				Stiffer Fine Grained Alluvium - Stiff Lean Clays (CL)	200	30	-	-	120			
Station 78+00 West	Rapid Drawdown	Waterside	Design Water Surface Elevation 160.4	**Levee Fill**	200	27	1000	15	115	1.0	1.12	Cohesive Soils: First Stage of analyses- Use effective stress envelopes. Second Stage Analyses- Use undrained shear strength values
		2.3H:1V slope	drops to	**Softer Fine Grained Alluvium Outside Levee**- CH (Fat Clays)	70	27	100	17	110		Block Specified	
			Water level in channel under normal winter conditions, El. 145	**Stiffer Fine Grained Alluvium Under Levee -** CL	200	30	400	17	120			
				Peat- PT	0	30	0	17	70			
				Peat Under Levee- PT	0	30	0	17	70			
				Stiffer Fine Grained Alluvium- CH (Fat Clays)	200	30	400	17	120			
				Coarse Grained Alluvium (>12 percent fines) - Loose to Medium Dense Silty Sand Layer Interbedded with Stiff Lean Clays (SM / CL)	0	32	0	32	120			
				Coarse Grained Alluvium (5 to 12 percent fines) -Medium Dense to Dense Poorly Graded/ Silty Sands (SP/SM)	0	35	0	35	140			Granular Soils - Use Drained (Effective)- Strength Parameters
				Stiffer Fine Grained Alluvium - Stiff Lean Clays (CL)	200	30	200	30	120			
Station 78+00 East	Rapid Drawdown	Waterside	Design Water Surface Elevation 160.4	**Levee Fill**	200	27	1000	15	115	1.0	1.07	
		2.3H:1V slope	drops to	**Softer Fine Grained Alluvium Outside Levee**- CH (Fat Clays)	70	27	100	17	110		Block Specified	Cohesive Soils: First Stage of analyses- Use effective stress envelopes. Second Stage Analyses- Use undrained shear strength values
			Water level in channel under normal winter conditions, El. 145	**Stiffer Fine Grained Alluvium Under Levee -** CL	200	30	400	17	120			
				Peat- PT	0	30	0	17	70			
				Peat Under Levee- PT	0	30	0	17	70			
				Stiffer Fine Grained Alluvium- CH (Fat Clays)	200	30	400	17	120			
				Coarse Grained Alluvium (>12 percent fines) - Loose to Medium Dense Silty Sand Layer Interbedded with Stiff Lean Clays (SM / CL)	0	32	0	32	120			
				Coarse Grained Alluvium (5 to 12 percent fines) -Medium Dense to Dense Poorly Graded/ Silty Sands (SP/SM)	0	35	0	35	140			
				Stiffer Fine Grained Alluvium - Stiff Lean Clays (CL)	200	30	200	30	120			Granular Soils - Use Drained (Effective)- Strength Parameters

TABLE F-3
SUMMARY OF SLOPE STABILITY ANALYSES - STA 92+50 (REACH 2A)

				Model Parameters						Min. Required Factor of Safety		
					Strength Parameters				Unit Weight		**Calculated**	
Section	**Case**	**Analyzed Slope**	**Water Surface**	Layers	c'	phi'	c	phi	(pcf)		**Factor of Safety**	Notes
Station 92+50 West	Steady-State Seepage	Landside	Design Water Surface Elevation 163.0	**Levee Fill**	200	27	-	-	115	1.4	2.19	Drained Strength Parameters
		3.2H:1V slope		**Softer Fine Grained Alluvium** -CH (Fat Clays)	70	27	-	-	110			
				Stiffer Fine Grained Alluvium Under Levee -Stiff Lean Clays and Silts (CL/ ML)	200	30	-	-	120			
				Coarse Grained Alluvium (5 to 12 percent fines) -Medium Dense to Dense Poorly Graded/ Silty Sands (SP/SM)	0	35	-	-	140			
				Stiffer Fine Grained Alluvium -Stiff Lean Clays and Silts (CL/ ML)	200	30	-	-	120			
Station 92+50 East	Steady-State Seepage	Landside	Design Water Surface Elevation 163.0	**Levee Fill**	200	27	-	-	115	1.4	1.97	Drained Strength Parameters
		3.2H:1V slope		**Softer Fine Grained Alluvium** -CH (Fat Clays)	70	27	-	-	110			
				Stiffer Fine Grained Alluvium Under Levee -Stiff Lean Clays and Silts (CL/ ML)	200	30	-	-	120			
				Stiffer Fine Grained Alluvium -Stiff Lean Clays and Silts (CL/ ML)	200	30	-	-	120			
				Coarse Grained Alluvium (5 to 12 percent fines) -Medium Dense to Dense Poorly Graded/ Silty Sands (SP/SM)	0	35	-	-	140			
				Stiffer Fine Grained Alluvium -Stiff Lean Clays and Silts (CL/ ML)	200	30	-	-	120			
Station 92+50 West	Rapid Drawdown	Waterside	Design Water Surface Elevation 163.0	**Levee Fill**	200	27	1000	15	115	1.0	1.53	Cohesive Soils: First Stage of analyses- Use effective stress envelopes. Second Stage Analyses- Use undrained shear strength values Granular Soils - Use Drained (Effective)- Strength Parameters
		2.8H:1V slope	drops to Water level in channel under normal winter condtions, El. 147	**Softer Fine Grained Alluvium** -CH (Fat Clays)	70	27	100	17	110			
				Stiffer Fine Grained Alluvium Under Levee -Stiff Lean Clays and Silts (CL/ ML)	200	30	400	17	120			
				Coarse Grained Alluvium (5 to 12 percent fines) -Medium Dense to Dense Poorly Graded/ Silty Sands (SP/SM)	0	35	0	35	140			
				Stiffer Fine Grained Alluvium -Stiff Lean Clays and Silts (CL/ ML)	200	30	400	17	120			
Station 92+50 East	Rapid Drawdown	Waterside	Design Water Surface Elevation 163.0	**Levee Fill**	200	27	1000	15	115	1.0	1.45	Cohesive Soils: First Stage of analyses- Use effective stress envelopes. Second Stage Analyses- Use undrained shear strength values Granular Soils - Use Drained (Effective)- Strength Parameters
		2.6H:1V slope	drops to Water level in channel under normal winter condtions, El. 147	**Softer Fine Grained Alluvium** -CH (Fat Clays)	70	27	100	17	110			
				Stiffer Fine Grained Alluvium Under Levee -Stiff Lean Clays and Silts (CL/ ML)	200	30	400	17	120			
				Stiffer Fine Grained Alluvium -Stiff Lean Clays and Silts (CL/ ML)	200	30	400	17	120			
				Coarse Grained Alluvium (5 to 12 percent fines) -Medium Dense to Dense Poorly Graded/ Silty Sands (SP/SM)	0	35	0	35	140			
				Stiffer Fine Grained Alluvium -Stiff Lean Clays and Silts (CL/ ML)	200	30	400	17	120			

TABLE F-4
SUMMARY OF SLOPE STABILITY ANALYSES - STA 106+50 (REACH 2A)

Section	**Case**	**Analyzed Slope**	**Water Surface**	Model Parameters						Min. Required Factor of Safety	**Calculated Factor of Safety**	Notes
					Strength Parameters				Unit Weight			
				Layers	c'	phi'	c	phi	(pcf)			
Station 106+50 West	Steady-State Seepage	Landside	Design Water Surface Elevation 165.3	**Levee Fill**	200	27	-	-	115	1.4	1.91	Drained Strength Parameters
		3.3H:1V slope		**Stiffer Fine Grained Alluvium Under Levee -** Stiff Lean Clays and Silts (CL/ ML)	200	30	-	-	120			
				Softer Fine Grained Alluvium Outside Levee	70	27	-	-	110			
				Coarse Grained Alluvium- Medium Dense to Dense Silty to Poorly Graded Sands (SM/SP)	0	35	-	-	140			
				Stiffer Fine Grained Alluvium- Stiff Lean Clays and Silts (CL/ ML)	200	30	-	-	120			
Station 106+50 East	Steady-State Seepage	Landside	Design Water Surface Elevation 165.3	**Levee Fill**	200	27	-	-	115	1.4	1.99	Drained Strength Parameters
		3.3H:1V slope		**Stiffer Fine Grained Alluvium Under Levee -** Stiff Lean Clays and Silts (CL/ ML)	200	30	-	-	120			
				Softer Fine Grained Alluvium Outside Levee	70	27	-	-	110			
				Coarse Grained Alluvium- Medium Dense to Dense Silty to Poorly Graded Sands (SM/SP)	0	35	-	-	140			
				Stiffer Fine Grained Alluvium- Stiff Lean Clays and Silts (CL/ ML)	200	30	-	-	120			
Station 106+50 West	Rapid Drawdown	Waterside	Design Water Surface Elevation 165.3	**Levee Fill**	200	27	1000	15	115	1.0	1.93	Cohesive Soils: First Stage of analyses- Use effective stress envelopes. Second Stage Analyses- Use undrained shear strength values Granular Soils - Use Drained (Effective)- Strength Parameters
		3.2H:1V slope	drops to Water level in channel under normal winter conditions, El. 149	**Stiffer Fine Grained Alluvium Under Levee -** Stiff Lean Clays and Silts (CL/ ML)	200	30	400	17	120			
				Softer Fine Grained Alluvium Outside Levee	70	27	100	17	110			
				Coarse Grained Alluvium- Medium Dense to Dense Silty to Poorly Graded Sands (SM/SP)	0	35	0	35	140			
				Stiffer Fine Grained Alluvium- Stiff Lean Clays and Silts (CL/ ML)	200	30	400	17	120			
Station 106+50 East	Rapid Drawdown	Waterside	Design Water Surface Elevation 165.3	**Levee Fill**	200	27	1000	15	115	1.0	1.23	Cohesive Soils: First Stage of analyses- Use effective stress envelopes. Second Stage Analyses- Use undrained shear strength values Granular Soils - Use Drained (Effective)- Strength Parameters
		2.1H:1V slope	drops to Water level in channel under normal winter conditions, El. 149	**Stiffer Fine Grained Alluvium Under Levee -** Stiff Lean Clays and Silts (CL/ ML)	200	30	400	17	120			
				Softer Fine Grained Alluvium Outside Levee	70	27	100	17	110			
				Coarse Grained Alluvium- Medium Dense to Dense Silty to Poorly Graded Sands (SM/SP)	0	35	0	35	140			
				Stiffer Fine Grained Alluvium- Stiff Lean Clays and Silts (CL/ ML)	200	30	400	17	120			

TABLE F-5
SUMMARY OF SLOPE STABILITY ANALYSES - STA 126+00

Section	Case	Analyzed Slope	Water Surface	Model Parameters						Min. Required Factor of Safety	**Calculated Factor of Safety**	Notes
				Layers	Strength Parameters				Unit Weight (pcf)			
					c'	phi'	c	phi				
Station 126+00 East	Steady-State Seepage	Landside	Design Water Surface Elevation 169.5	**Levee Fill-** Lean Clay Fill Material (CL)	200	27	-	-	115	1.4	2.13	Drained Strength Parameters
		2.1H:1V slope		**Stiff Fine Grained Alluvium Under Levee-** Stiff to Very Stiff Lean Clay (CL)	200	30	-	-	120			
				Soft Fine Grained Alluvium Outside Levee	70	27	-	-	110			
				Coarse Grained Alluvium- Dense to Very Dense Poorly Graded Sands and Gravels (SP/GP)	0	35	-	-	140			
				Stiff Fine Grained Alluvium- Stiff Lean Clays and Silts (CL/ ML)	200	30	-	-	120			
				Coarse Grained Alluvium- Very Dense Poorly Graded Gravels (GP)	0	35	-	-	140			
				Stiff Fine Grained Alluvium- Stiff Lean Clays and Silts (CL/ ML)	200	30	-	-	120			
Station 126+00 West	Rapid Drawdown	Waterside	Design Water Surface Elevation 169.5	**Stiff Fine Grained Alluvium-** Stiff to Very Stiff Lean Clay (CL)	200	30	400	17	120	1.0	2.29	Cohesive Soils: First Stage of analyses- Use effective stress envelopes. Second Stage Analyses- Use undrained shear strength values
		2.8H:1V slope	drops to	**Coarse Grained Alluvium-** Dense to Very Dense Poorly Graded Sands and Gravels (SP/GP)	0	35	0	35	140			
			Water level in channel under normal winter conditions, El. 153	**Stiff Fine Grained Alluvium-** Stiff Lean Clays and Silts (CL/ ML)	200	30	400	17	120			
				Coarse Grained Alluvium- Very Dense Poorly Graded Gravels (GP)	0	35	0	35	140			
				Stiff Fine Grained Alluvium- Stiff Lean Clays and Silts (CL/ ML)	200	30	400	17	120			Granular Soils - Use Drained (Effective)- Strength Parameters
Station 126+00 East	Rapid Drawdown	Waterside	Design Water Surface Elevation 169.5	**Levee Fill-** Lean Clay Fill Material (CL)	200	27	1000	15	115	1.0	1.36	Cohesive Soils: First Stage of analyses- Use effective stress envelopes. Second Stage Analyses- Use undrained shear strength values
		2.4H:1V slope	drops to Water level in channel under normal winter conditions, El. 153	**Stiff Fine Grained Alluvium Under Levee-** Stiff to Very Stiff Lean Clay (CL)	200	30	400	17	120			
				Soft Fine Grained Alluvium Outside Levee	70	27	100	17	110			
				Coarse Grained Alluvium- Dense to Very Dense Poorly Graded Sands and Gravels (SP/GP)	0	35	0	35	140			
				Stiff Fine Grained Alluvium- Stiff Lean Clays and Silts (CL/ ML)	200	30	400	17	120			
				Coarse Grained Alluvium- Very Dense Poorly Graded Gravels (GP)	0	35	0	35	140			
				Stiff Fine Grained Alluvium- Stiff Lean Clays and Silts (CL/ ML)	200	30	400	17	120			Granular Soils - Use Drained (Effective)- Strength Parameters

Note - There is no levee on the landside section of 126+00 west. The rapid drawdown evaluation on the waterside will be performed to evaluate channel stability of the waterside slope.
Based on the dense to very dense relative density of the underlying sands and gravels, and stiff consistency of the clay materials, liquefaction of granular soils or strain softening of cohesive soils under seismic loading are not anticipated.
Therefore, a seismic evaluation was deemed not necessary for Section 126+00 on both the west and east sides of the channel.

TABLE F-6
SUMMARY OF SLOPE STABILITY ANALYSES - STA 134+00 (REACH 2B)

				Model Parameters						Min. Required Factor of Safety		
					Strength Parameters				Unit Weight		**Calculated**	
Section	**Case**	**Analyzed Slope**	**Water Surface**	Layers	c'	phi'	c	phi	(pcf)		**Factor of Safety**	Notes
Station 134+00 West	Rapid Drawdown	Waterside 1.5H:1V slope	Design Water Surface Elevation 170.8 drops to Water level in channel under normal winter conditions, El. 155	**Artificial Fill-** Stiff Lean Clay Fill Material (CL)	200	30	400	17	115	1.0	1.53	Cohesive Soils: First Stage of analyses- Use effective stress envelopes. Second Stage Analyses- Use undrained shear strength values Granular Soils - Use Drained (Effective)- Strength Parameters
				Stiffer Fine Grained Alluvium- Stiff to Very Stiff Lean Clay (CL)	200	30	400	17	120			
				Coarse Grained Alluvium- Loose to Medium Dense Poorly Graded Sands with Silt (SP/SM)	0	35	0	35	140			
				Coarse Grained Alluvium- Dense to Very Dense Poorly Graded Sands and Gravels (SP/GP)	0	35	0	35	140			
				Stiffer Fine Grained Alluvium- Stiff Lean Clays and Silts (CL/ ML)	200	30	400	17	120			
Station 134+00 East	Rapid Drawdown	Waterside 2.5H:1V slope	Design Water Surface Elevation 170.8 drops to Water level in channel under normal winter conditions, El. 155	**Levee Fill (CH)**	200	27	1000	15	115	1.0	2.03	Cohesive Soils: First Stage of analyses- Use effective stress envelopes. Second Stage Analyses- Use undrained shear strength values Granular Soils - Use Drained (Effective)- Strength Parameters
				Stiffer Fine Grained Alluvium- Stiff to Very Stiff Lean/ Fat Clay (CL/CH)	200	30	400	17	120			
				Coarse Grained Alluvium- Loose to Medium Dense Poorly Graded Sands with Silt (SP/SM)	0	35	0	35	140			
				Coarse Grained Alluvium- Dense to Very Dense Poorly Graded sands and Gravels (SP/GP)	0	35	0	35	140			
				Stiffer Fine Grained Alluvium- Stiff Lean Clays (CL)	200	30	400	17	120			

Note - There is no levee on the landside section of 134+00 west. The levee on the east side of Section 134+00 is above the design water surface elevation and provides a minimum 3-feet freeboard protection.The rapid drawdown evaluation on the waterside will be performed to evaluate channel stability of the waterside slopes within the channel
Based on the dense to very dense relative density of the underlying sands and gravels, and stiff consistency of the clay materials, liquefaction of granular soils or strain softening of cohesive soils under seismic loading are not anticipated
Therefore, a seismic evaluation was deemed not necessary for Section 126+00 on both the west and east sides of the channel.

TABLE F-7
SUMMARY OF SLOPE STABILITY ANALYSES - STA 166+50 (REACH 2B)

				Model Parameters						Min. Required Factor of Safety		
					Strength Parameters				Unit Weight		**Calculated**	
Section	**Case**	**Analyzed Slope**	**Water Surface**	Layers	c'	phi'	c	phi	(pcf)		**Factor of Safety**	Notes
Station 166+50 West	Rapid Drawdown	Waterside	Design Water Surface Elevation 177.8	**Artificial Fill-** Stiff Lean Clay Fill Material (CL)	200	30	400	17	115	1.0	1.91	Cohesive Soils: First Stage of analyses- Use effective stress envelopes. Second Stage Analyses- Use undrained shear strength values
		2.4H:1V slope	drops to	**Coarse Grained Alluvium -** Loose Medium Dense Silty Sands (SM) and some Sandy Silts (ML)	0	32	0	32	120			
			Water level in channel under normal winter conditions, El. 164	**Stiffer Fine Grained Alluvium-** Stiff to Very Stiff Lean Clay (CL)	200	30	400	17	120			
				Coarse Grained Alluvium- Medium Dense Poorly Graded Sands with Silt (SP/SM)	0	35	0	35	140			
				Coarse Grained Alluvium- Dense to Very Dense Poorly Graded Sands and Gravels (SP/GP)	0	35	0	35	140			Granular Soils - Use Drained (Effective)- Strength Parameters
				Stiffer Fine Grained Alluvium- Stiff Lean Clays and Silts (CL/ ML)	200	30	400	17	120			
Station 166+50 East	Rapid Drawdown	Waterside	Design Water Surface Elevation 177.8	**Stiffer Fine Grained Alluvium**- Stiff to Very Stiff Lean Clay (CL)	200	30	400	17	120	1.0	1.84	Cohesive Soils: First Stage of analyses- Use effective stress envelopes. Second Stage Analyses- Use undrained shear strength values
		2.2H:1V slope	drops to	**Coarse Grained Alluvium -** Loose Medium Dense Silty Sands (SM) and some Sandy Silts (ML)	0	32	0	32	120			
			Water level in channel under normal winter conditions, El. 164	**Stiffer Fine Grained Alluvium-** Stiff to Very Stiff Lean Clays and Sandy Silts (CL/ML)	200	30	400	17	120			
				Coarse Grained Alluvium- Medium Dense Poorly Graded Sands with Silt (SP-SM)	0	35	0	35	140			
				Coarse Grained Alluvium- Dense to Very Dense Poorly Graded sands and Gravels (SP/GP)	0	35	0	35	140			
				Stiffer Fine Grained Alluvium- Stiff to Very Stiff Lean Clays and Sandy Silts (CL/ML)	200	30	400	17	120			Granular Soils - Use Drained (Effective)- Strength Parameters

Note- There is no levee on the landside of Section 166+50 East. The levee on the west side of Section 166+50 is above the 100-year water surface and above the 3-foot freeboard elevation for the 100-year surface.

The rapid drawdown evaluation on the waterside will be performed to address channel stability of the 2.4H to 1V and 2.2H to 1V waterside slopes on the west and east sides of the channel, respectively.

Lower Llagas Creek Capacity Restoration Capital Project

Station 50+00 Steady-State Stability Analysis - West Levee

Model stratigraphy and characteristics developed using geologic information
from CPT-049+00E, B-050+00W, and CPT-050+00W
Topography based on 2007 LiDAR data provided by SCVWD for Project use
Design Water Surface Elevation (Design WSE) provided by SCVWD
All elevations reference North American Vertical Datum of 1988 (NAVD88)

Analysis Section Details

Design WSE* - 154.8'
*Design WSE greater than top of levees, therefore, the analysis was run at WSE - 154.0'

West Levee

Levee Fill
Unit Weight: 115 pcf
Cohesion: 200 psf
Phi: 27 °

Peat
Unit Weight: 70 pcf
Cohesion: 0 psf
Phi: 30 °

Coarse Grained Alluvium < 5% Fines
Unit Weight: 140 pcf
Cohesion: 0 psf
Phi: 35 °

Softer Fine Grained Alluvium
Unit Weight: 110 pcf
Cohesion: 70 psf
Phi: 27 °

Stiffer Fine Grained Alluvium
Unit Weight: 120 pcf
Cohesion: 200 psf
Phi: 30 °

Loose Levee Fill
Unit Weight: 110 pcf
Cohesion: 50 psf
Phi: 27 °

Crest Elevation	154.1'
Crest Width	22.3'
Waterside Slope	2.5H:1V
Waterside Toe Elevation	139.0'
Landside Slope	3.3H:1V
Landside Toe Elevation	144.0'
Factor of Safety	1.94

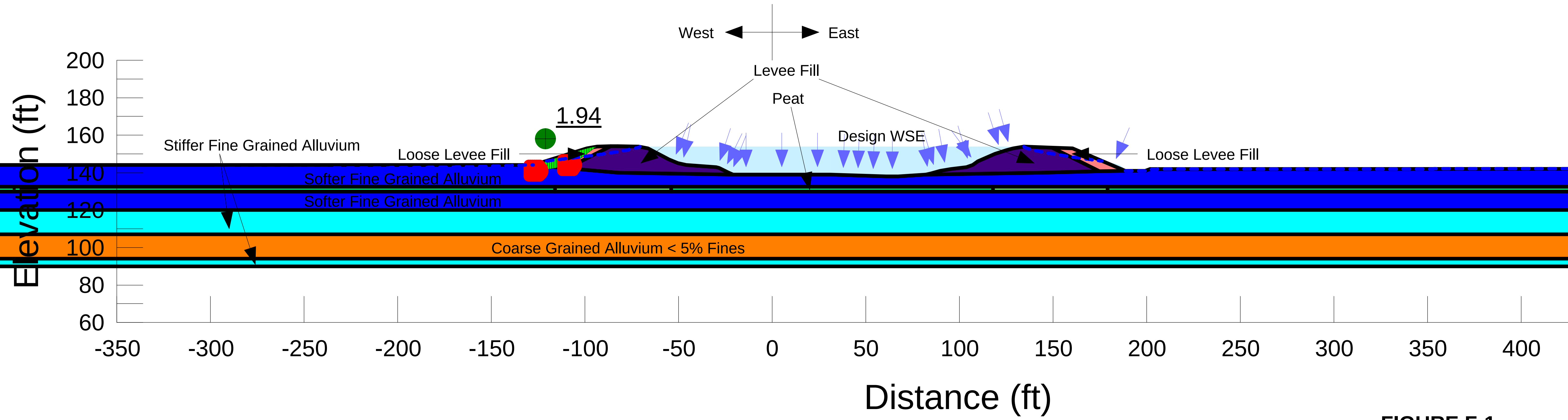


FIGURE F-1

Lower Llagas Creek Capacity Restoration Capital Project

Station 50+00 Steady-State Stability Analysis - East Levee

Model stratigraphy and characteristics developed using geologic information
from CPT-049+00E, B-050+00W, and CPT-050+00W
Topography based on 2007 LiDAR data provided by SCVWD for Project use
Design Water Surface Elevation (Design WSE) provided by SCVWD
All elevations reference North American Vertical Datum of 1988 (NAVD88)

Analysis Section Details

Design WSE* - 154.8'
*Design WSE greater than top of levees, therefore, the analysis was run at WSE - 154.0'

East Levee

Levee Fill
Unit Weight: 115 pcf
Cohesion: 200 psf
Phi: 27 °

Peat
Unit Weight: 70 pcf
Cohesion: 0 psf
Phi: 30 °

Coarse Grained Alluvium < 5% Fines
Unit Weight: 140 pcf
Cohesion: 0 psf
Phi: 35 °

Crest Elevation	154.0'
Crest Width	26.0'
Waterside Slope	2.7H:1V
Waterside Toe Elevation	138.0'
Landside Slope	2.2H:1V
Landside Toe Elevation	141.0'
Factor of Safety	1.45

Softer Fine Grained Alluvium
Unit Weight: 110 pcf
Cohesion: 70 psf
Phi: 27 °

Stiffer Fine Grained Alluvium
Unit Weight: 120 pcf
Cohesion: 200 psf
Phi: 30 °

Loose Levee Fill
Unit Weight: 110 pcf
Cohesion: 50 psf
Phi: 27 °

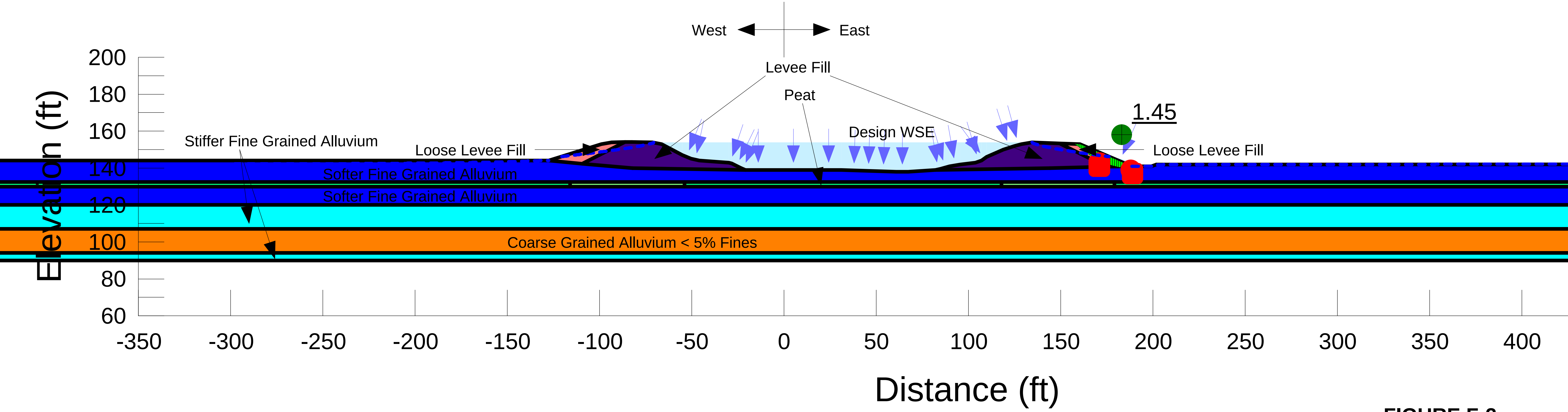


FIGURE F-2

Lower Llagas Creek Capacity Restoration Capital Project

Station 50+00 Rapid Drawdown Stability Analysis - West Levee

Model stratigraphy and characteristics developed using geologic information
from CPT-049+00E, B-050+00W, and CPT-050+00W
Topography based on 2007 LiDAR data provided by SCVWD for Project use
Design Water Surface Elevation (Design WSE) provided by SCVWD
All elevations reference North American Vertical Datum of 1988 (NAVD88)

Analysis Section Details

Design WSE* - 154.8'
*Design WSE greater than top of
levees, therefore, the analysis
was run at WSE - 154.0'

West Levee

Crest Elevation	154.1'
Crest Width	22.3'
Waterside Slope	2.5H:1V
Waterside Toe Elevation	139.0'
Landside Slope	3.3H:1V
Landside Toe Elevation	144.0'
Factor of Safety	1.46

Levee Fill
Unit Weight: 115 pcf
Cohesion: 200 psf
Phi: 27 °
Drawdown Total Cohesion: 1000 psf
Drawdown Total Phi: 15 °

Peat
Unit Weight: 70 pcf
Cohesion: 0 psf
Phi: 30 °
Drawdown Total Cohesion: 0 psf
Drawdown Total Phi: 17 °

Coarse Grained Alluvium < 5% Fines
Unit Weight: 140 pcf
Cohesion: 0 psf
Phi: 35 °

Softer Fine Grained Alluvium
Unit Weight: 110 pcf
Cohesion: 70 psf
Phi: 27 °
Drawdown Total Cohesion: 100 psf
Drawdown Total Phi: 17 °

Stiffer Fine Grained Alluvium
Unit Weight: 120 pcf
Cohesion: 200 psf
Phi: 30 °
Drawdown Total Cohesion: 400 psf
Drawdown Total Phi: 17 °

Loose Levee Fill
Unit Weight: 110 pcf
Cohesion: 50 psf
Phi: 27 °
Drawdown Total Cohesion: 500 psf
Drawdown Total Phi: 15 °

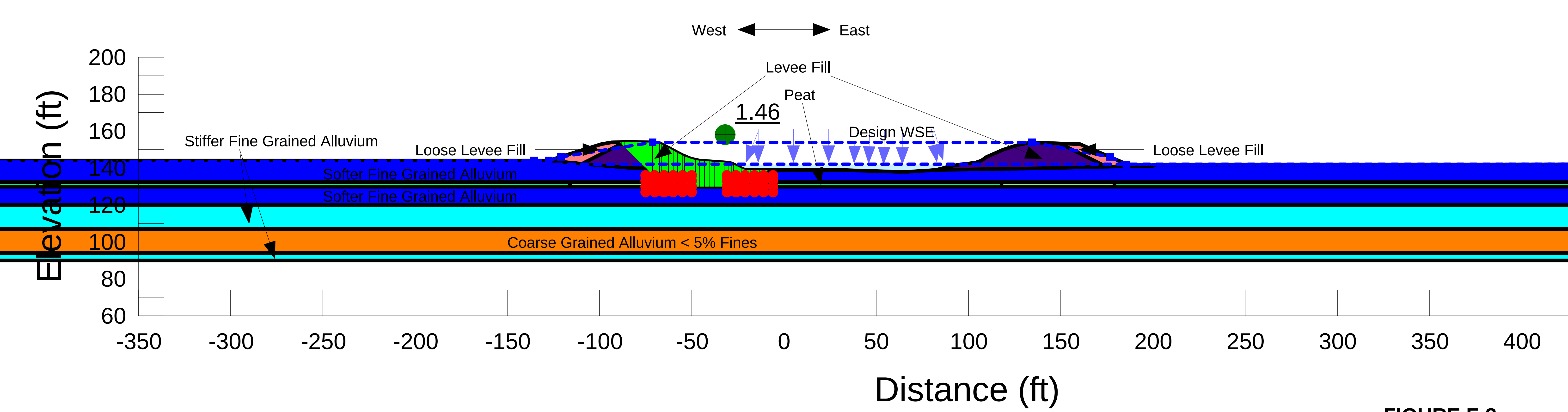


FIGURE F-3

Lower Llagas Creek Capacity Restoration Capital Project

Station 50+00 Rapid Drawdown Stability Analysis - East Levee

Model stratigraphy and characteristics developed using geologic information
from CPT-049+00E, B-050+00W, and CPT-050+00W
Topography based on 2007 LiDAR data provided by SCVWD for Project use
Design Water Surface Elevation (Design WSE) provided by SCVWD
All elevations reference North American Vertical Datum of 1988 (NAVD88)

Analysis Section Details

Design WSE* - 154.8'
*Design WSE greater than top of levees, therefore, the analysis was run at WSE - 154.0'

East Levee

Crest Elevation	154.0'
Crest Width	26.0'
Waterside Slope	2.7H:1V
Waterside Toe Elevation	138.0'
Landside Slope	2.2H:1V
Landside Toe Elevation	141.0'
Factor of Safety	1.39

Levee Fill
Unit Weight: 115 pcf
Cohesion: 200 psf
Phi: 27 °
Drawdown Total Cohesion: 1000 psf
Drawdown Total Phi: 15 °

Peat
Unit Weight: 70 pcf
Cohesion: 0 psf
Phi: 30 °
Drawdown Total Cohesion: 0 psf
Drawdown Total Phi: 17 °

Coarse Grained Alluvium < 5% Fines
Unit Weight: 140 pcf
Cohesion: 0 psf
Phi: 35 °

Softer Fine Grained Alluvium
Unit Weight: 110 pcf
Cohesion: 70 psf
Phi: 27 °
Drawdown Total Cohesion: 100 psf
Drawdown Total Phi: 17 °

Stiffer Fine Grained Alluvium
Unit Weight: 120 pcf
Cohesion: 200 psf
Phi: 30 °
Drawdown Total Cohesion: 400 psf
Drawdown Total Phi: 17 °

Loose Levee Fill
Unit Weight: 110 pcf
Cohesion: 50 psf
Phi: 27 °
Drawdown Total Cohesion: 500 psf
Drawdown Total Phi: 15 °

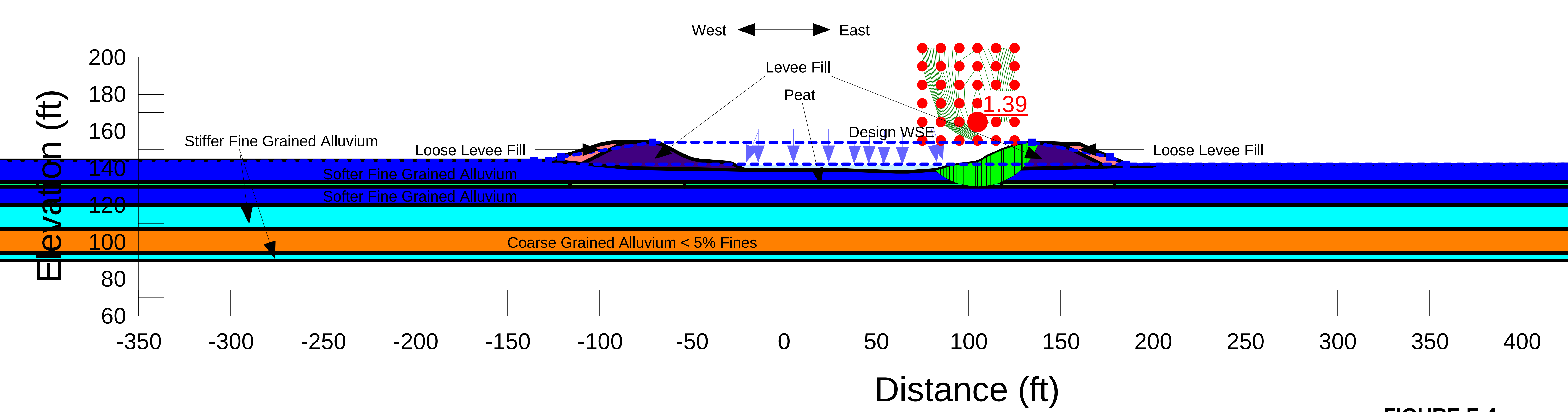


FIGURE F-4

Lower Llagas Creek Capacity Restoration Capital Project

Station 50+00 End-of-Construction (New Levee Fill) Stability Analysis - West Levee

Model stratigraphy and characteristics developed using geologic information
from CPT-049+00E, B-050+00W, and CPT-050+00W
Topography based on 2007 LiDAR data provided by SCVWD for Project use
Design Water Surface Elevation (Design WSE) provided by SCVWD
All elevations reference North American Vertical Datum of 1988 (NAVD88)

Analysis Section Details

Winter WSE - 142.0'

West Levee

Levee Fill
Unit Weight: 115 pcf
Cohesion: 1450 psf

Peat
Unit Weight: 70 pcf
Cohesion: 500 psf

Coarse Grained Alluvium < 5% Fines
Unit Weight: 140 pcf
Cohesion: 0 psf
Phi: 35 °

Softer Fine Grained Alluvium
Unit Weight: 110 pcf
Upper Layer Cohesion: 750 psf
Lower Layer Cohesion: 1000 psf

Stiffer Fine Grained Alluvium
Unit Weight: 120 pcf
Cohesion: 1500 psf

New Levee Fill
Unit Weight: 120 pcf
Cohesion: 1450 psf

New Crest Elevation	157.8'
New Crest Width	15.0'
Waterside Slope	2.5H:1V
Waterside Toe Elevation	139.0'
New Landside Slope	2.2H:1V
Landside Toe Elevation	144.0'
Factor of Safety	3.02

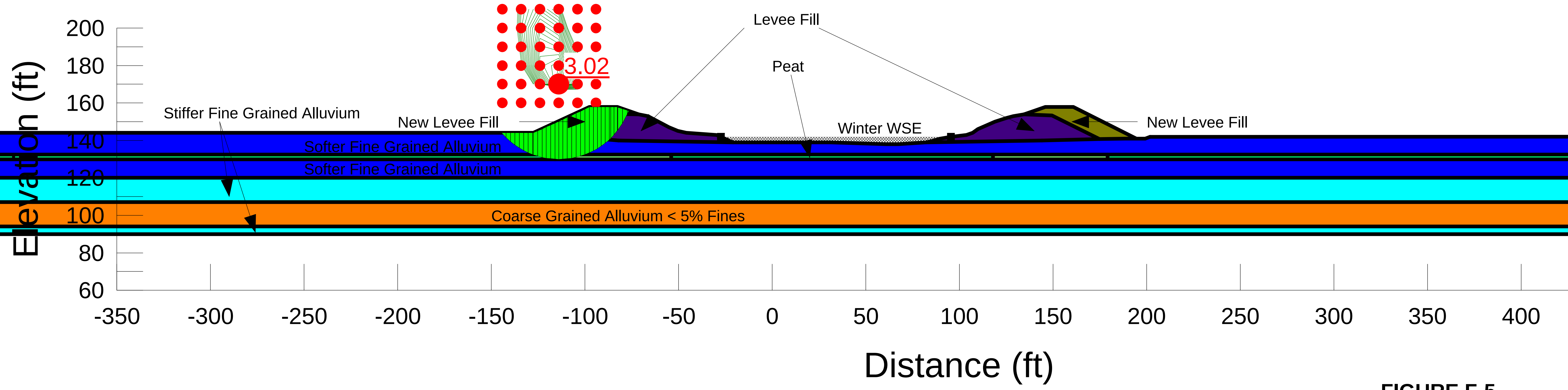


FIGURE F-5

Lower Llagas Creek Capacity Restoration Capital Project

Station 50+00 End-of-Construction (New Levee Fill) Stability Analysis - West Levee

Model stratigraphy and characteristics developed using geologic information
from CPT-049+00E, B-050+00W, and CPT-050+00W
Topography based on 2007 LiDAR data provided by SCVWD for Project use
Design Water Surface Elevation (Design WSE) provided by SCVWD
All elevations reference North American Vertical Datum of 1988 (NAVD88)

Analysis Section Details

Winter WSE - 142.0'

West Levee

Levee Fill
Unit Weight: 115 pcf
Cohesion: 1450 psf

Peat
Unit Weight: 70 pcf
Cohesion: 500 psf

Coarse Grained Alluvium < 5% Fines
Unit Weight: 140 pcf
Cohesion: 0 psf
Phi: 35 °

Softer Fine Grained Alluvium
Unit Weight: 110 pcf
Upper Layer Cohesion: 750 psf
Lower Layer Cohesion: 1000 psf

Stiffer Fine Grained Alluvium
Unit Weight: 120 pcf
Cohesion: 1500 psf

New Levee Fill
Unit Weight: 120 pcf
Cohesion: 1450 psf

New Crest Elevation	157.8'
New Crest Width	15.0'
Waterside Slope	2.5H:1V
Waterside Toe Elevation	139.0'
New Landside Slope	2.2H:1V
Landside Toe Elevation	144.0'
Factor of Safety	2.83

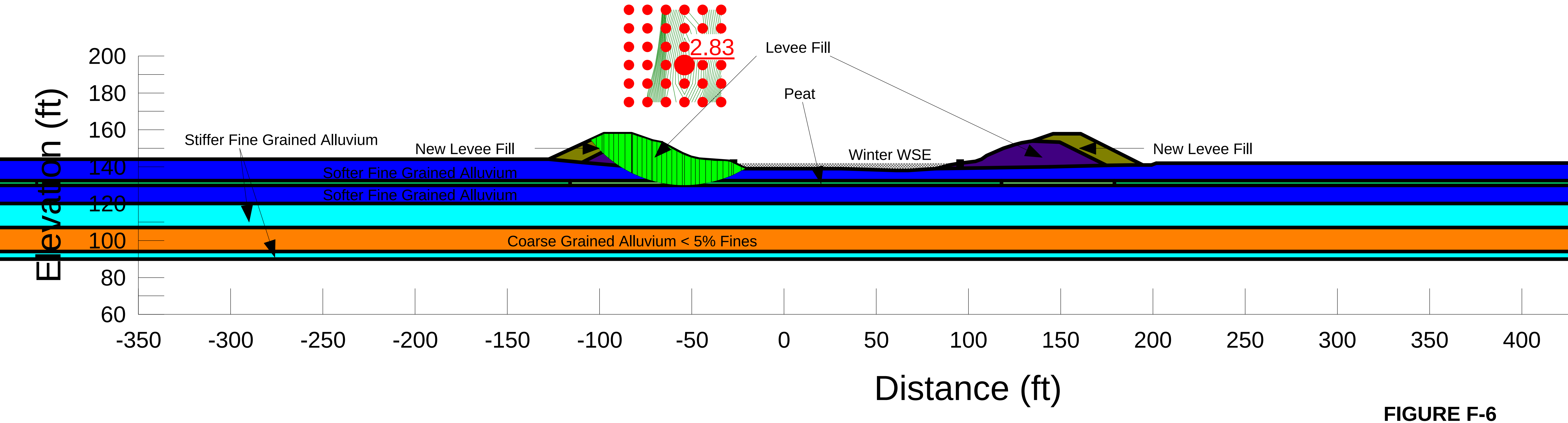


FIGURE F-6

Lower Llagas Creek Capacity Restoration Capital Project

Station 50+00 End-of-Construction (New Levee Fill) Stability Analysis - East Levee

Model stratigraphy and characteristics developed using geologic information
from CPT-049+00E, B-050+00W, and CPT-050+00W
Topography based on 2007 LiDAR data provided by SCVWD for Project use
Design Water Surface Elevation (Design WSE) provided by SCVWD
All elevations reference North American Vertical Datum of 1988 (NAVD88)

Analysis Section Details
Winter WSE - 142.0'

East Levee

Levee Fill
Unit Weight: 115 pcf
Cohesion: 1450 psf

Peat
Unit Weight: 70 pcf
Cohesion: 500 psf

Coarse Grained Alluvium < 5% Fines
Unit Weight: 140 pcf
Cohesion: 0 psf
Phi: 35 °

New Crest Elevation	157.8'
New Crest Width	15.0'
Waterside Slope	2.7H:1V
Waterside Toe Elevation	138.0'
New Landside Slope	2.0H:1V
Landside Toe Elevation	141.0'
Factor of Safety	2.66

Softer Fine Grained Alluvium
Unit Weight: 110 pcf
Upper Layer Cohesion: 750 psf
Lower Layer Cohesion: 1000 psf

Stiffer Fine Grained Alluvium
Unit Weight: 120 pcf
Cohesion: 1500 psf

New Levee Fill
Unit Weight: 120 pcf
Cohesion: 1450 psf

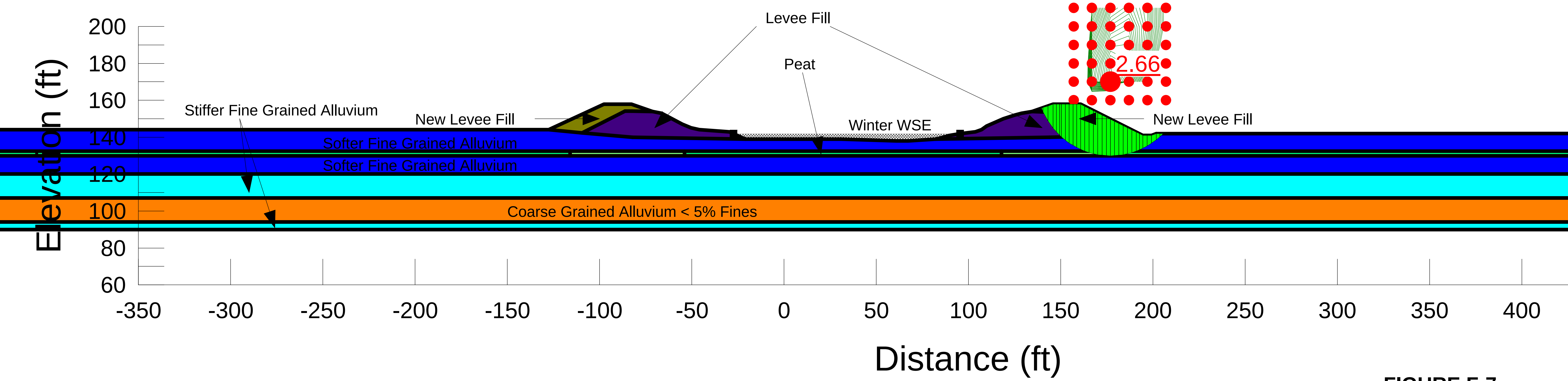


FIGURE F-7

Lower Llagas Creek Capacity Restoration Capital Project

Station 50+00 End-of-Construction (New Levee Fill) Stability Analysis - East Levee

Model stratigraphy and characteristics developed using geologic information
from CPT-049+00E, B-050+00W, and CPT-050+00W
Topography based on 2007 LiDAR data provided by SCVWD for Project use
Design Water Surface Elevation (Design WSE) provided by SCVWD
All elevations reference North American Vertical Datum of 1988 (NAVD88)

Analysis Section Details
Winter WSE - 142.0'

East Levee

Levee Fill
Unit Weight: 115 pcf
Cohesion: 1450 psf

Peat
Unit Weight: 70 pcf
Cohesion: 500 psf

Coarse Grained Alluvium < 5% Fines
Unit Weight: 140 pcf
Cohesion: 0 psf
Phi: 35 °

New Crest Elevation	157.8'
New Crest Width	15.0'
Waterside Slope	2.7H:1V
Waterside Toe Elevation	138.0'
New Landside Slope	2.0H:1V
Landside Toe Elevation	141.0'
Factor of Safety	2.80

Softer Fine Grained Alluvium
Unit Weight: 110 pcf
Upper Layer Cohesion: 750 psf
Lower Layer Cohesion: 1000 psf

Stiffer Fine Grained Alluvium
Unit Weight: 120 pcf
Cohesion: 1500 psf

New Levee Fill
Unit Weight: 120 pcf
Cohesion: 1450 psf

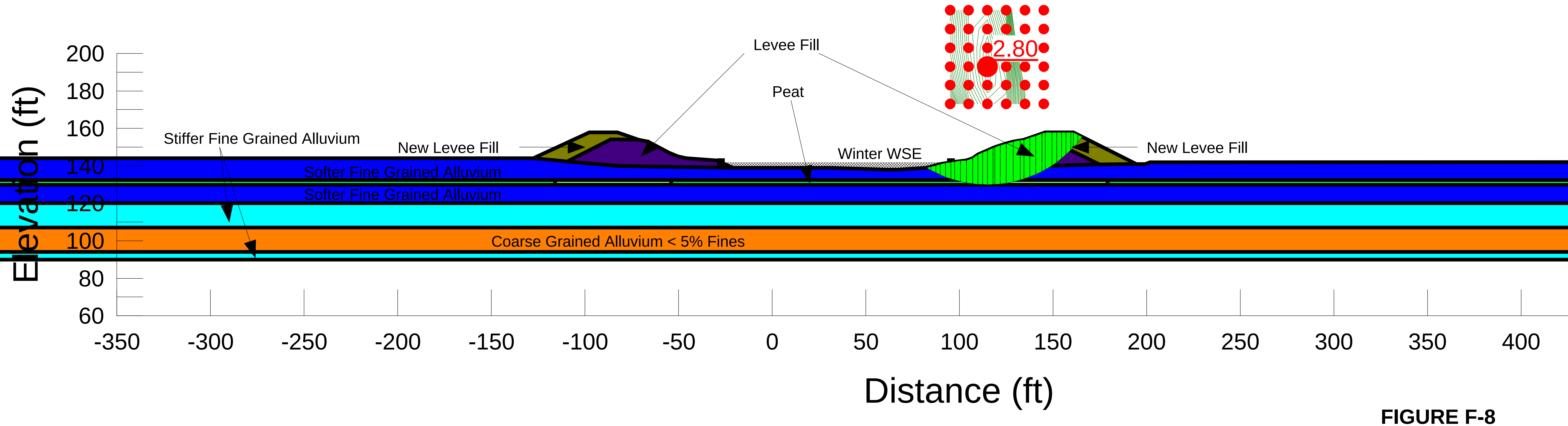


FIGURE F-8

Lower Llagas Creek Capacity Restoration Capital Project

Station 50+00 End-of-Construction (Strip Load) Stability Analysis - West Levee

Model stratigraphy and characteristics developed using geologic information
from CPT-049+00E, B-050+00W, and CPT-050+00W
Topography based on 2007 LiDAR data provided by SCVWD for Project use
Design Water Surface Elevation (Design WSE) provided by SCVWD
All elevations reference North American Vertical Datum of 1988 (NAVD88)

Analysis Section Details

Winter WSE - 142.0'

West Levee

Levee Fill
Unit Weight: 115 pcf
Cohesion: 1450 psf

Peat
Unit Weight: 70 pcf
Cohesion: 500 psf

Coarse Grained Alluvium < 5% Fines
Unit Weight: 140 pcf
Cohesion: 0 psf
Phi: 35 °

Crest Elevation	154.1'
Crest Width	22.3'
Waterside Slope	2.5H:1V
Waterside Toe Elevation	139.0'
Landside Slope	3.3H:1V
Landside Toe Elevation	144.0'
Factory of Safety	3.68

Softer Fine Grained Alluvium
Unit Weight: 110 pcf
Upper Layer Cohesion: 750 psf
Lower Layer Cohesion: 1000 psf

Stiffer Fine Grained Alluvium
Unit Weight: 120 pcf
Cohesion: 1500 psf

Loose Levee Fill
Unit Weight: 110 pcf
Cohesion: 850 psf

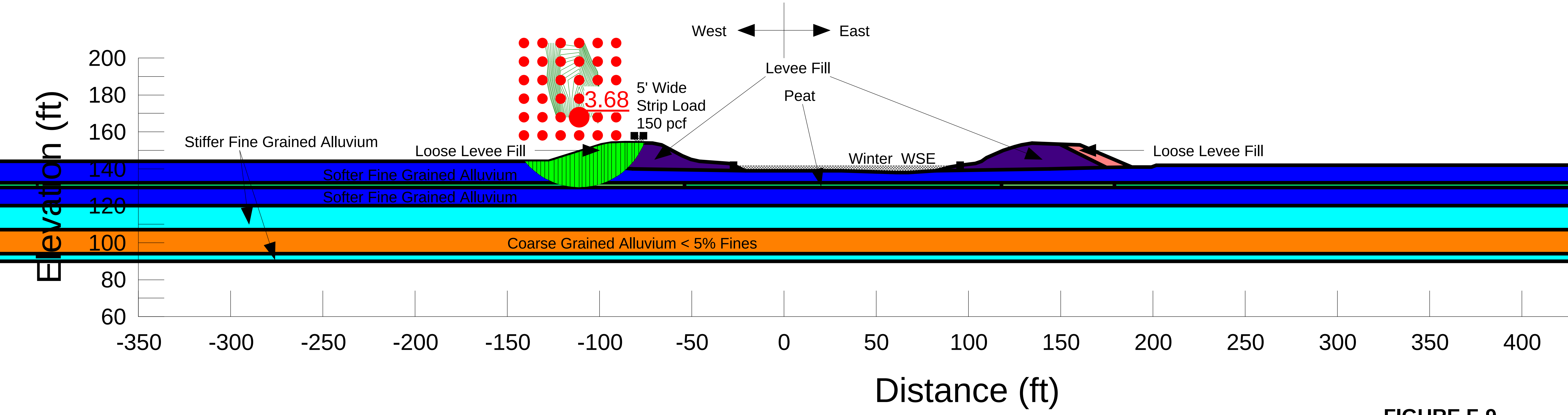


FIGURE F-9

Lower Llagas Creek Capacity Restoration Capital Project

Station 50+00 End-of-Construction (Strip Load) Stability Analysis - West Levee

Model stratigraphy and characteristics developed using geologic information
from CPT-049+00E, B-050+00W, and CPT-050+00W
Topography based on 2007 LiDAR data provided by SCVWD for Project use
Design Water Surface Elevation (Design WSE) provided by SCVWD
All elevations reference North American Vertical Datum of 1988 (NAVD88)

Analysis Section Details

Winter WSE - 142.0'

West Levee

Levee Fill
Unit Weight: 115 pcf
Cohesion: 1450 psf

Peat
Unit Weight: 70 pcf
Cohesion: 500 psf

Coarse Grained Alluvium < 5% Fines
Unit Weight: 140 pcf
Cohesion: 0 psf
Phi: 35 °

Softer Fine Grained Alluvium
Unit Weight: 110 pcf
Upper Layer Cohesion: 750 psf
Lower Layer Cohesion: 1000 psf

Stiffer Fine Grained Alluvium
Unit Weight: 120 pcf
Cohesion: 1500 psf

Loose Levee Fill
Unit Weight: 110 pcf
Cohesion: 850 psf

Crest Elevation	154.1'
Crest Width	22.3'
Waterside Slope	2.5H:1V
Waterside Toe Elevation	139.0'
Landside Slope	3.3H:1V
Landside Toe Elevation	144.0'
Factory of Safety	3.21

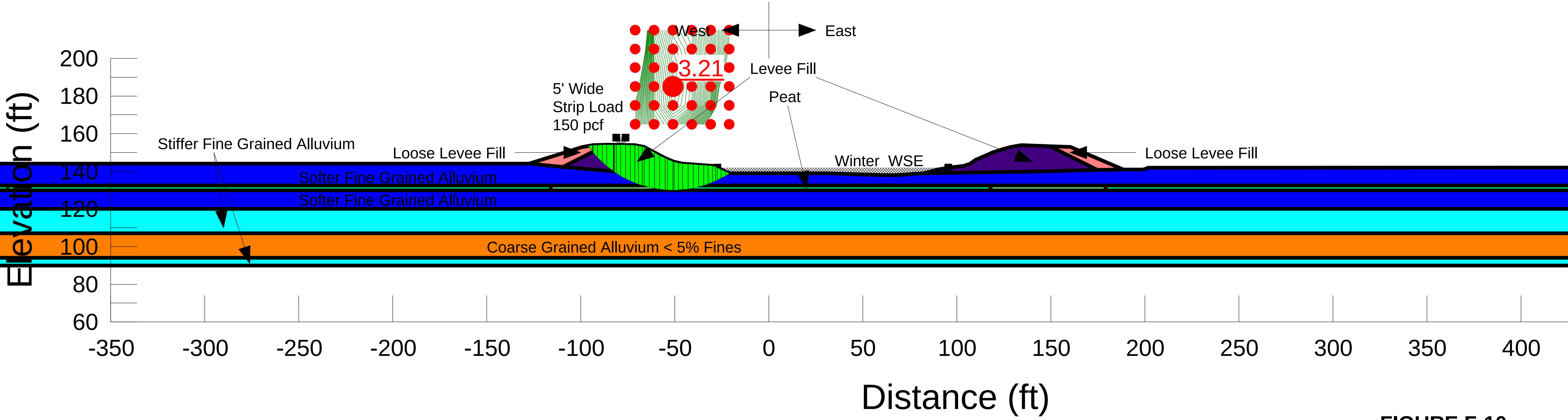


FIGURE F-10

Lower Llagas Creek Capacity Restoration Capital Project

Station 50+00 End-of-Construction (Strip Load) Stability Analysis - East Levee

Model stratigraphy and characteristics developed using geologic information
from CPT-049+00E, B-050+00W, and CPT-050+00W
Topography based on 2007 LiDAR data provided by SCVWD for Project use
Design Water Surface Elevation (Design WSE) provided by SCVWD
All elevations reference North American Vertical Datum of 1988 (NAVD88)

Analysis Section Details
Winter WSE - 142.0'

East Levee

Levee Fill
Unit Weight: 115 pcf
Cohesion: 1450 psf

Peat
Unit Weight: 70 pcf
Cohesion: 500 psf

Coarse Grained Alluvium < 5% Fines
Unit Weight: 140 pcf
Cohesion: 0 psf
Phi: 35 °

Crest Elevation	154.0'
Crest Width	26.0'
Waterside Slope	2.7H:1V
Waterside Toe Elevation	138.0'
Landside Slope	2.2H:1V
Landside Toe Elevation	141.0'
Factory of Safety	3.08

Softer Fine Grained Alluvium
Unit Weight: 110 pcf
Upper Layer Cohesion: 750 psf
Lower Layer Cohesion: 1000 psf

Stiffer Fine Grained Alluvium
Unit Weight: 120 pcf
Cohesion: 1500 psf

Loose Levee Fill
Unit Weight: 110 pcf
Cohesion: 850 psf

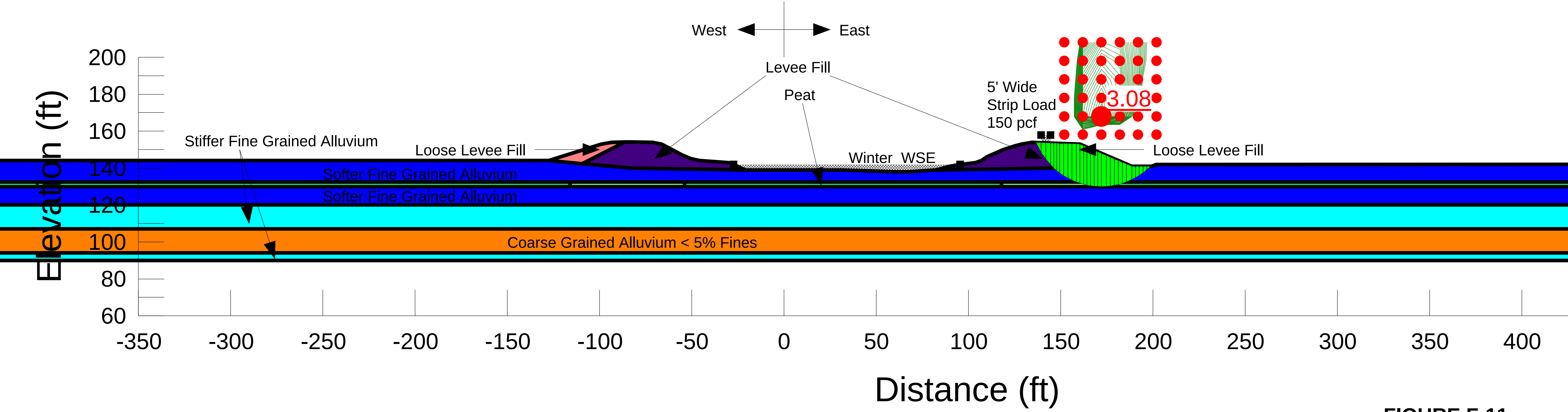


FIGURE F-11

Lower Llagas Creek Capacity Restoration Capital Project

Station 50+00 End-of-Construction (Strip Load) Stability Analysis - East Levee

Model stratigraphy and characteristics developed using geologic information
from CPT-049+00E, B-050+00W, and CPT-050+00W
Topography based on 2007 LiDAR data provided by SCVWD for Project use
Design Water Surface Elevation (Design WSE) provided by SCVWD
All elevations reference North American Vertical Datum of 1988 (NAVD88)

Analysis Section Details

Winter WSE - 142.0'

East Levee

Levee Fill
Unit Weight: 115 pcf
Cohesion: 1450 psf

Peat
Unit Weight: 70 pcf
Cohesion: 500 psf

Coarse Grained Alluvium < 5% Fines
Unit Weight: 140 pcf
Cohesion: 0 psf
Phi: 35 °

Crest Elevation	154.0'
Crest Width	26.0'
Waterside Slope	2.7H:1V
Waterside Toe Elevation	138.0'
Landside Slope	2.2H:1V
Landside Toe Elevation	141.0'
Factory of Safety	3.03

Softer Fine Grained Alluvium
Unit Weight: 110 pcf
Upper Layer Cohesion: 750 psf
Lower Layer Cohesion: 1000 psf

Stiffer Fine Grained Alluvium
Unit Weight: 120 pcf
Cohesion: 1500 psf

Loose Levee Fill
Unit Weight: 110 pcf
Cohesion: 850 psf

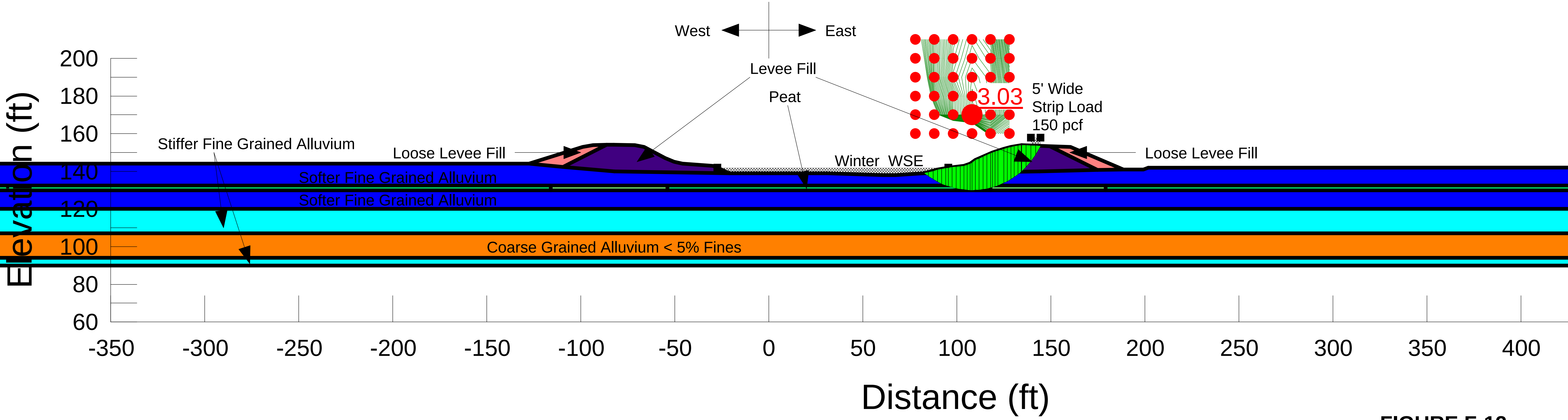


FIGURE F-12

Lower Llagas Creek Capacity Restoration Capital Project

Station 78+00 Steady-State Stability Analysis - West Levee

Model stratigraphy and characteristics developed using geologic information
from B-078+00W, CPT-078+00W, and CPT-074+50E
Topography based on 2007 LiDAR data provided by SCVWD for Project use
Design Water Surface Elevation (Design WSE) provided by SCVWD
All elevations reference North American Vertical Datum of 1988 (NAVD 1988)

Analysis Section Details

Design WSE - 160.5'

West Levee

Levee Fill
Unit Weight: 115 pcf
Cohesion: 200 psf
Phi: 27 °

Peat
Unit Weight: 70 pcf
Cohesion: 0 psf
Phi: 30 °

Coarse Grained Alluvium > 12% Fines
Unit Weight: 120 pcf
Cohesion: 0 psf
Phi: 32 °

Softer Fine Grained Alluvium
Unit Weight: 110 pcf
Cohesion: 70 psf
Phi: 27 °

Stiffer Fine Grained Alluvium
Unit Weight: 120 pcf
Cohesion: 200 psf
Phi: 30 °

Coarse Grained Alluvium 5% < Fines < 12%
Unit Weight: 140 pcf
Cohesion: 0 psf
Phi: 35 °

Crest Elevation	163.0'
Crest Width	56.0'
Waterside Slope	2.3H:1V
Waterside Toe Elevation	142.0'
Landside Slope	2.7H:1V
Landside Toe Elevation	147.0'
Factor of Safety	1.79

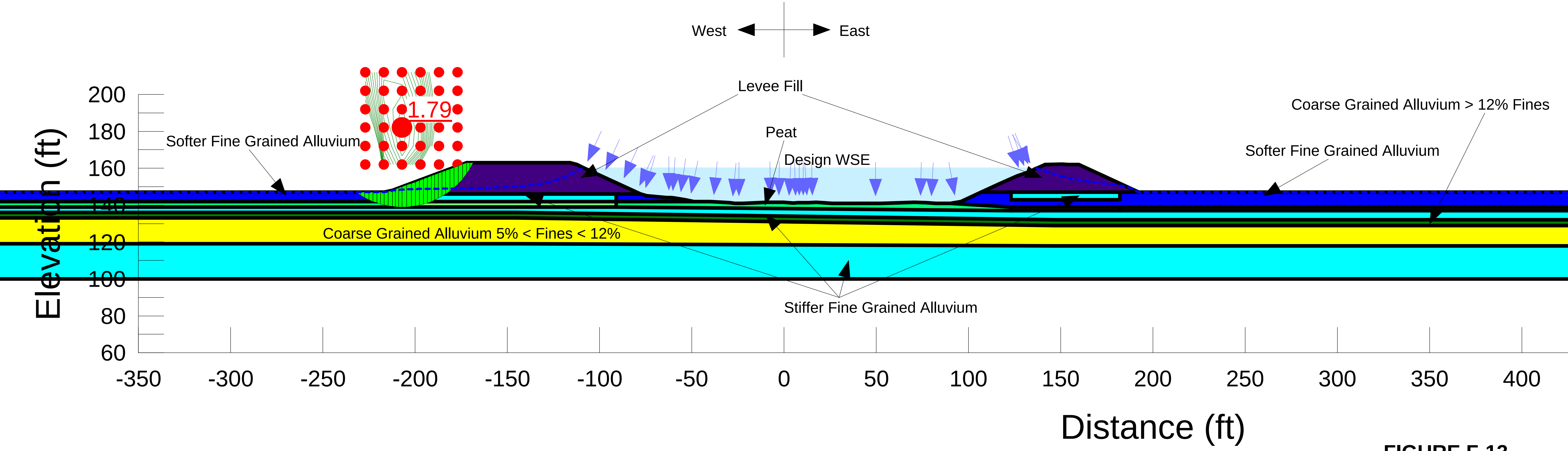

West
East
1.79
Levee Fill
Coarse Grained Alluvium > 12% Fines
Softer Fine Grained Alluvium
Peat
Design WSE
Softer Fine Grained Alluvium
Coarse Grained Alluvium 5% < Fines < 12%
Stiffer Fine Grained Alluvium
Elevation (ft)
200
180
160
140
120
100
80
60
-350
-300
-250
-200
-150
-100
-50
0
50
100
150
200
250
300
350
400
Distance (ft)

FIGURE F-13

Lower Llagas Creek Capacity Restoration Capital Project

Station 78+00 Steady-State Stability Analysis - East Levee

Model stratigraphy and characteristics developed using geologic information
from B-078+00W, CPT-078+00W, and CPT-074+50E
Topography based on 2007 LiDAR data provided by SCVWD for Project use
Design Water Surface Elevation (Design WSE) provided by SCVWD
All elevations reference North American Vertical Datum of 1988 (NAVD 1988)

Analysis Section Details

Design WSE - 160.5'

East Levee

Levee Fill
Unit Weight: 115 pcf
Cohesion: 200 psf
Phi: 27 °

Peat
Unit Weight: 70 pcf
Cohesion: 0 psf
Phi: 30 °

Coarse Grained Alluvium > 12% Fines
Unit Weight: 120 pcf
Cohesion: 0 psf
Phi: 32 °

Crest Elevation	162.2'
Crest Width	18.2'
Waterside Slope	2.3H:1V
Waterside Toe Elevation	141.0'
Landside Slope	2.2H:1V
Landside Toe Elevation	147.0'
Factor of Safety	1.62

Softer Fine Grained Alluvium
Unit Weight: 110 pcf
Cohesion: 70 psf
Phi: 27 °

Stiffer Fine Grained Alluvium
Unit Weight: 120 pcf
Cohesion: 200 psf
Phi: 30 °

Coarse Grained Alluvium 5% < Fines < 12%
Unit Weight: 140 pcf
Cohesion: 0 psf
Phi: 35 °

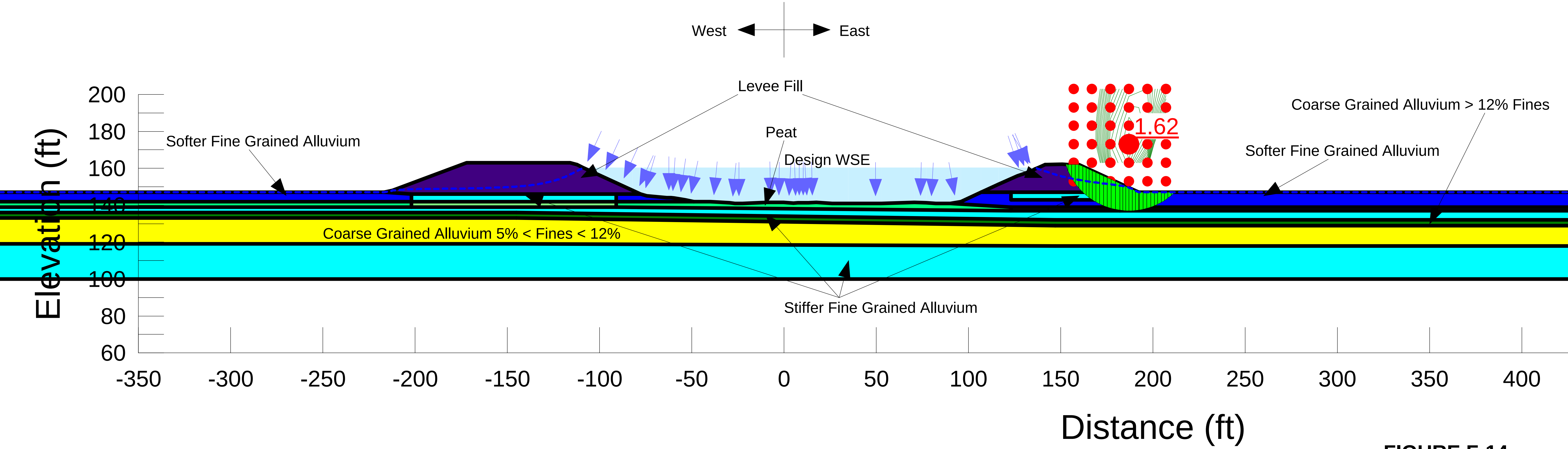

West
East
Levee Fill
Coarse Grained Alluvium > 12% Fines
1.62
Softer Fine Grained Alluvium
Peat
Design WSE
Softer Fine Grained Alluvium
Coarse Grained Alluvium 5% < Fines < 12%
Stiffer Fine Grained Alluvium
Elevation (ft)
200
180
160
140
120
100
80
60
-350
-300
-250
-200
-150
-100
-50
0
50
100
150
200
250
300
350
400
Distance (ft)

FIGURE F-14

Lower Llagas Creek Capacity Restoration Capital Project

Station 78+00 Rapid Drawdown Stability Analysis - West Levee

Model stratigraphy and characteristics developed using geologic information
from B-078+00W, CPT-078+00W, and CPT-074+50E
Topography based on 2007 LiDAR data provided by SCVWD for Project use
Design Water Surface Elevation (Design WSE) provided by SCVWD
All elevations reference North American Vertical Datum of 1988 (NAVD 1988)

Analysis Section Details
Design WSE - 160.5'
Winter WSE - 145.0'

West Levee

Levee Fill
Unit Weight: 115 pcf
Cohesion: 200 psf
Phi: 27 °
Drawdown Total Cohesion: 1000 psf
Drawdown Total Phi: 15 °

Peat
Unit Weight: 70 pcf
Cohesion: 0 psf
Phi: 30 °
Drawdown Total Cohesion: 0 psf
Drawdown Total Phi: 17 °

Coarse Grained Alluvium > 12% Fines
Unit Weight: 120 pcf
Cohesion: 0 psf
Phi: 32 °

Crest Elevation	163.0'
Crest Width	56.0'
Waterside Slope	2.3H:1V
Waterside Toe Elevation	142.0'
Landside Slope	2.7H:1V
Landside Toe Elevation	147.0'
Factor of Safety	1.12

Softer Fine Grained Alluvium
Unit Weight: 110 pcf
Cohesion: 70 psf
Phi: 27 °
Drawdown Total Cohesion: 100 psf
Drawdown Total Phi: 17 °

Stiffer Fine Grained Alluvium
Unit Weight: 120 pcf
Cohesion: 200 psf
Phi: 30 °
Drawdown Total Cohesion: 400 psf
Drawdown Total Phi: 17 °

Coarse Grained Alluvium 5% < Fines < 12%
Unit Weight: 140 pcf
Cohesion: 0 psf
Phi: 35 °

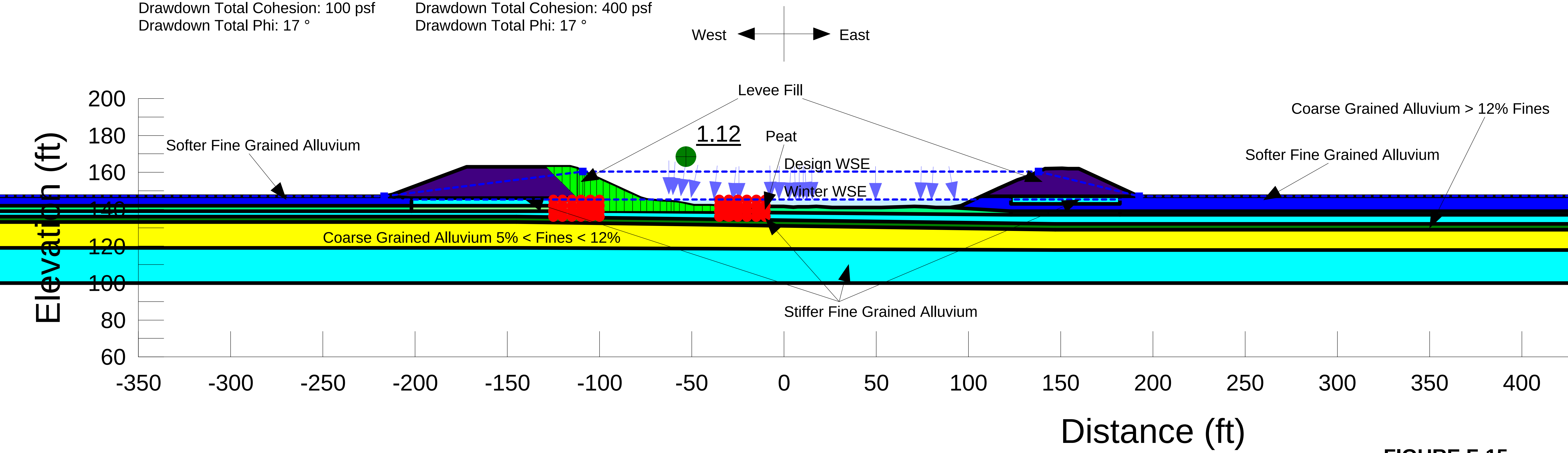

West
East
Levee Fill
1.12
Peat
Design WSE
Winter WSE
Softer Fine Grained Alluvium
Coarse Grained Alluvium > 12% Fines
Softer Fine Grained Alluvium
Coarse Grained Alluvium 5% < Fines < 12%
Stiffer Fine Grained Alluvium
Elevation (ft)
200
180
160
140
120
100
80
60
-350
-300
-250
-200
-150
-100
-50
0
50
100
150
200
250
300
350
400
Distance (ft)

FIGURE F-15

Lower Llagas Creek Capacity Restoration Capital Project

Station 78+00 Rapid Drawdown Stability Analysis - East Levee

Model stratigraphy and characteristics developed using geologic information
from B-078+00W, CPT-078+00W, and CPT-074+50E
Topography based on 2007 LiDAR data provided by SCVWD for Project use
Design Water Surface Elevation (Design WSE) provided by SCVWD
All elevations reference North American Vertical Datum of 1988 (NAVD 1988)

Analysis Section Details

Design WSE - 160.5'
Winter WSE - 145.0'

East Levee

Levee Fill
Unit Weight: 115 pcf
Cohesion: 200 psf
Phi: 27 °
Drawdown Total Cohesion: 1000 psf
Drawdown Total Phi: 15 °

Peat
Unit Weight: 70 pcf
Cohesion: 0 psf
Phi: 30 °
Drawdown Total Cohesion: 0 psf
Drawdown Total Phi: 17 °

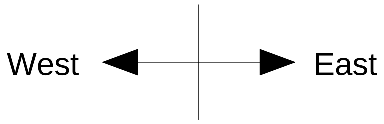
Coarse Grained Alluvium > 12% Fines
Unit Weight: 120 pcf
Cohesion: 0 psf
Phi: 32 °

Crest Elevation	162.2'
Crest Width	18.2'
Waterside Slope	2.3H:1V
Waterside Toe Elevation	141.0'
Landside Slope	2.2H:1V
Landside Toe Elevation	147.0'
Factor of Safety	1.07

Softer Fine Grained Alluvium
Unit Weight: 110 pcf
Cohesion: 70 psf
Phi: 27 °
Drawdown Total Cohesion: 100 psf
Drawdown Total Phi: 17 °

Stiffer Fine Grained Alluvium
Unit Weight: 120 pcf
Cohesion: 200 psf
Phi: 30 °
Drawdown Total Cohesion: 400 psf
Drawdown Total Phi: 17 °

Coarse Grained Alluvium 5% < Fines < 12%
Unit Weight: 140 pcf
Cohesion: 0 psf
Phi: 35 °



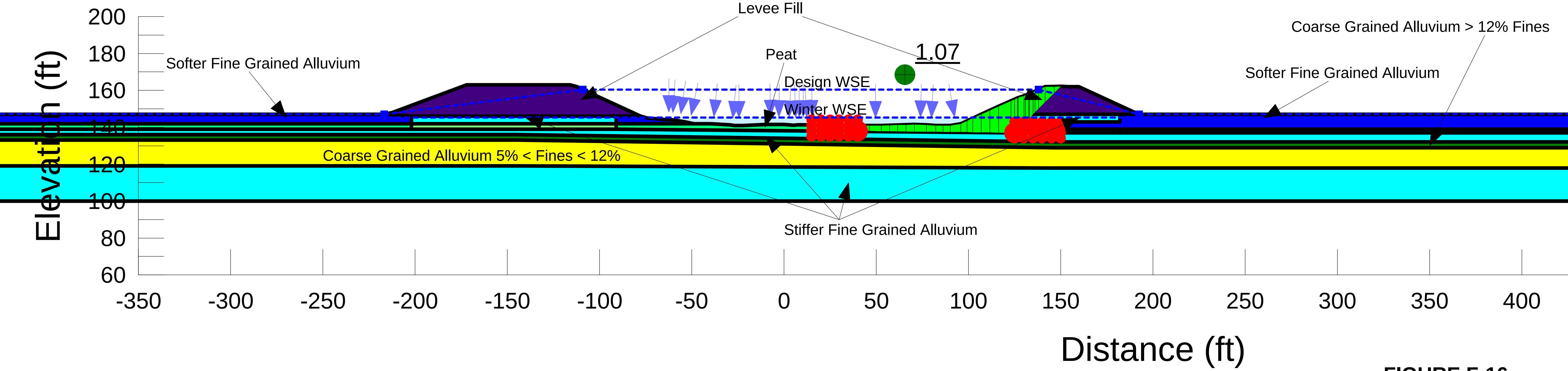

Levee Fill
Coarse Grained Alluvium > 12% Fines
Peat
1.07
Softer Fine Grained Alluvium
Design WSE
Softer Fine Grained Alluvium
Winter WSE
Coarse Grained Alluvium 5% < Fines < 12%
Stiffer Fine Grained Alluvium
200
180
160
140
120
100
80
60
Elevation (ft)
-350
-300
-250
-200
-150
-100
-50
0
50
100
150
200
250
300
350
400
Distance (ft)

FIGURE F-16

Lower Llagas Creek Capacity Restoration Capital Project

Station 92+50 Steady-State Stability Analysis - West Levee

Model stratigraphy and characteristics developed using geologic information
from B-092+50W, B-092+50E, and CPT-092+50E
Topography based on 2007 LiDAR data provided by SCVWD for Project ues
Design Water Surface Elevation (Design WSE) provided by SCVWD
All elevations reference North American Vertical Datum of 1988 (NAVD88)

Analysis Section Details

Design WSE - 163.0'

West Levee

Levee Fill
Unit Weight: 115 pcf
Cohesion: 200 psf
Phi: 27 °

Stiffer Fine Grained Alluvium
Unit Weight: 120 pcf
Cohesion: 200 psf
Phi: 30 °

Softer Fine Grained Alluvium
Unit Weight: 110 pcf
Cohesion: 70 psf
Phi: 27 °

Coarse Grained Alluvium 5% < Fines < 12%
Unit Weight: 140 pcf
Cohesion: 0 psf
Phi: 35 °

Crest Elevation	164.0'
Crest Width	24.0'
Waterside Slope	2.8H:1V
Waterside Toe Elevation	143.0'
Landside Slope	3.2H:1V
Landside Toe Elevation	150.0'
Factor of Safety	2.19

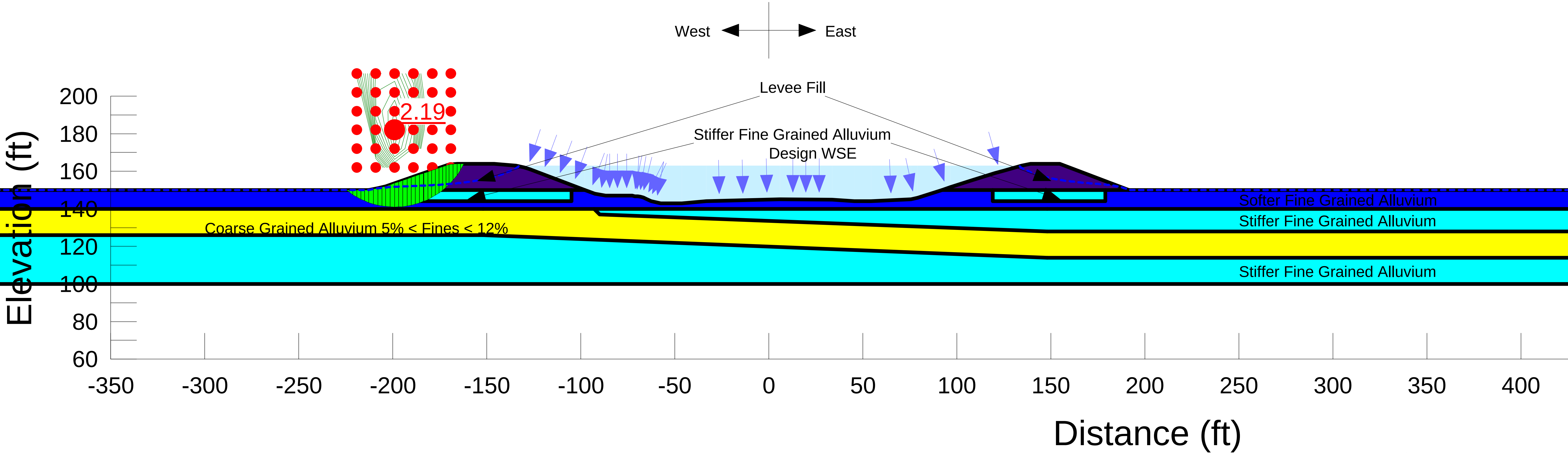


FIGURE F-17

Lower Llagas Creek Capacity Restoration Capital Project

Station 92+50 Steady-State Stability Analysis - East Levee

Model stratigraphy and characteristics developed using geologic information
from B-092+50W, B-092+50E, and CPT-092+50E
Topography based on 2007 LiDAR data provided by SCVWD for Project ues
Design Water Surface Elevation (Design WSE) provided by SCVWD
All elevations reference North American Vertical Datum of 1988 (NAVD88)

Analysis Section Details

Design WSE - 163.0'

East Levee

Levee Fill
Unit Weight: 115 pcf
Cohesion: 200 psf
Phi: 27 °

Stiffer Fine Grained Alluvium
Unit Weight: 120 pcf
Cohesion: 200 psf
Phi: 30 °

Softer Fine Grained Alluvium
Unit Weight: 110 pcf
Cohesion: 70 psf
Phi: 27 °

Coarse Grained Alluvium 5% < Fines < 12%
Unit Weight: 140 pcf
Cohesion: 0 psf
Phi: 35 °

Crest Elevation	164.0'
Crest Width	15.6'
Waterside Slope	3.2H:1V
Waterside Toe Elevation	144.0'
Landside Slope	2.6H:1V
Landside Toe Elevation	150.0'
Factor of Safety	1.97

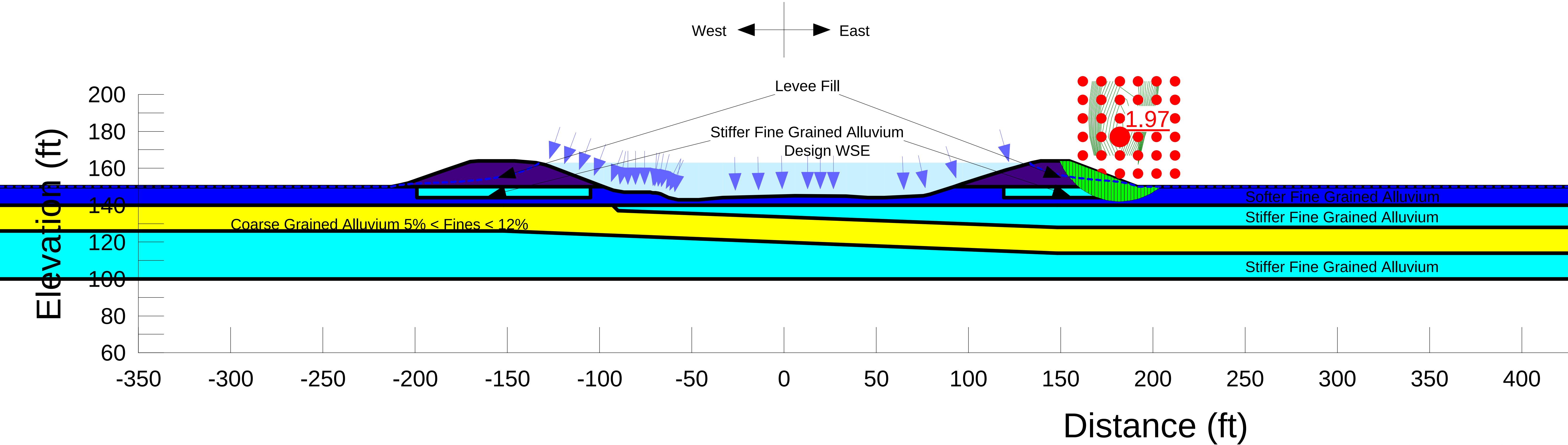

West
East
Levee Fill
Stiffer Fine Grained Alluvium
Design WSE
1.97
Softer Fine Grained Alluvium
Stiffer Fine Grained Alluvium
Coarse Grained Alluvium 5% < Fines < 12%
Stiffer Fine Grained Alluvium
Elevation (ft)
200
180
160
140
120
100
80
60
-350
-300
-250
-200
-150
-100
-50
0
50
100
150
200
250
300
350
400
Distance (ft)

FIGURE F-18

Lower Llagas Creek Capacity Restoration Capital Project

Station 92+50 Rapid Drawdown Stability Analysis - West Levee

Model stratigraphy and characteristics developed using geologic information
from B-092+50W, B-092+50E, and CPT-092+50E
Topography based on 2007 LiDAR data provided by SCVWD for Project ues
Design Water Surface Elevation (Design WSE) provided by SCVWD
All elevations reference North American Vertical Datum of 1988 (NAVD88)

Analysis Section Details
Design WSE - 163.0'
Winter WSE - 147.0'

West Levee

Levee Fill
Unit Weight: 115 pcf
Cohesion: 200 psf
Phi: 27 °
Drawdown Total Cohesion: 1000 psf
Drawdown Total Phi: 15 °

Stiffer Fine Grained Alluvium
Unit Weight: 120 pcf
Cohesion: 200 psf
Phi: 30 °
Drawdown Total Cohesion: 400 psf
Drawdown Total Phi: 17 °

Crest Elevation	164.0'
Crest Width	24.0'
Waterside Slope	2.8H:1V
Waterside Toe Elevation	143.0'
Landside Slope	3.2H:1V
Landside Toe Elevation	150.0'
Factor of Safety	1.53

Softer Fine Grained Alluvium
Unit Weight: 110 pcf
Cohesion: 70 psf
Phi: 27 °
Drawdown Total Cohesion: 100 psf
Drawdown Total Phi: 17 °

Coarse Grained Alluvium 5% < Fines < 12%
Unit Weight: 140 pcf
Cohesion: 0 psf
Phi: 35 °

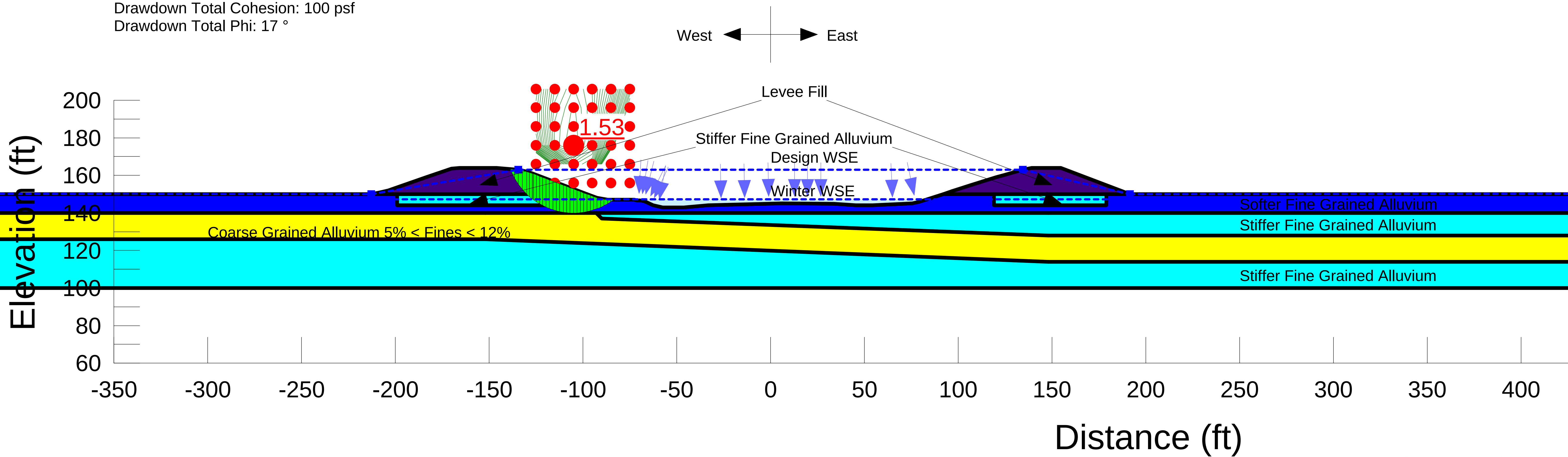

West
East
Levee Fill
1.53
Stiffer Fine Grained Alluvium
Design WSE
Winter WSE
Softer Fine Grained Alluvium
Stiffer Fine Grained Alluvium
Coarse Grained Alluvium 5% < Fines < 12%
Stiffer Fine Grained Alluvium
Elevation (ft)
200
180
160
140
120
100
80
60
-350
-300
-250
-200
-150
-100
-50
0
50
100
150
200
250
300
350
400
Distance (ft)

FIGURE F-19

Lower Llagas Creek Capacity Restoration Capital Project

Station 92+50 Rapid Drawdown Stability Analysis - East Levee

Model stratigraphy and characteristics developed using geologic information
from B-092+50W, B-092+50E, and CPT-092+50E
Topography based on 2007 LiDAR data provided by SCVWD for Project ues
Design Water Surface Elevation (Design WSE) provided by SCVWD
All elevations reference North American Vertical Datum of 1988 (NAVD88)

Analysis Section Details

Design WSE - 163.0'
Winter WSE - 147.0'

East Levee

Levee Fill
Unit Weight: 115 pcf
Cohesion: 200 psf
Phi: 27 °
Drawdown Total Cohesion: 1000 psf
Drawdown Total Phi: 15 °

Stiffer Fine Grained Alluvium
Unit Weight: 120 pcf
Cohesion: 200 psf
Phi: 30 °
Drawdown Total Cohesion: 400 psf
Drawdown Total Phi: 17 °

Crest Elevation	164.0'
Crest Width	15.6'
Waterside Slope	3.2H:1V
Waterside Toe Elevation	144.0'
Landside Slope	2.6H:1V
Landside Toe Elevation	150.0'
Factor of Safety	1.45

Softer Fine Grained Alluvium
Unit Weight: 110 pcf
Cohesion: 70 psf
Phi: 27 °
Drawdown Total Cohesion: 100 psf
Drawdown Total Phi: 17 °

Coarse Grained Alluvium 5% < Fines < 12%
Unit Weight: 140 pcf
Cohesion: 0 psf
Phi: 35 °

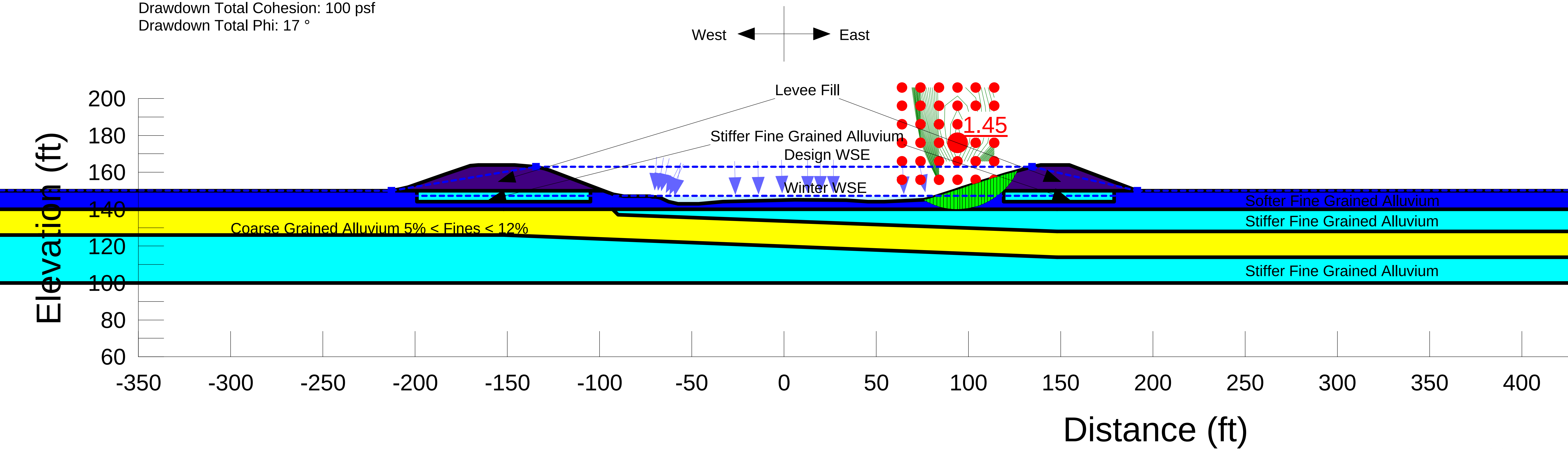

West
East
Levee Fill
Stiffer Fine Grained Alluvium
Design WSE
Winter WSE
1.45
Softer Fine Grained Alluvium
Stiffer Fine Grained Alluvium
Coarse Grained Alluvium 5% < Fines < 12%
Stiffer Fine Grained Alluvium
200
180
160
140
120
100
80
60
Elevation (ft)
-350
-300
-250
-200
-150
-100
-50
0
50
100
150
200
250
300
350
400
Distance (ft)

FIGURE F-20

Lower Llagas Creek Capacity Restoration Capital Project

Station 106+50 Steady-State Stability Analysis - West Levee

Model stratigraphy and characteristics developed using geologic information
from B-107+00W, CPT-107+00W, and CPT-108+50E
Topography based on 2007 LiDAR data provided by SCVWD for Project use
Design Water Surface Elevation (Design WSE) provided by SCVWD
All elevations reference North American Vertical Datum of 1988 (NAVD88)

Analysis Section Details
Design WSE - 165.3'

West Levee

Levee Fill
Unit Weight: 115 pcf
Cohesion: 200 psf
Phi: 27 °

Stiffer Fine Grained Alluvium
Unit Weight: 120 pcf
Cohesion: 200 psf
Phi: 30 °

Crest Elevation	166.0'
Crest Width	34.0'
Waterside Slope	3.2H:1V
Waterside Toe Elevation	145.0'
Landside Slope	3.3H:1V
Landside Toe Elevation	156.7'
Factor of Safety	1.91

Softer Fine Grained Alluvium
Unit Weight: 110 pcf
Cohesion: 70 psf
Phi: 27 °

Coarse Grained Alluvium 5% < Fines < 12%
Unit Weight: 140 pcf
Cohesion: 0 psf
Phi: 35 °

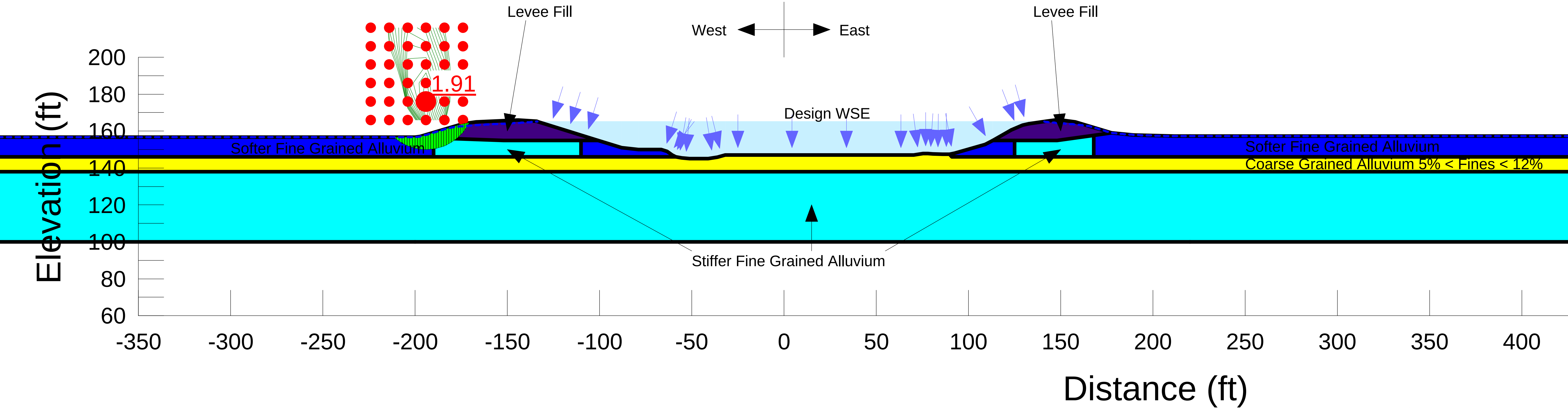


FIGURE F-21

Lower Llagas Creek Capacity Restoration Capital Project

Station 106+50 Steady-State Stability Analysis - East Levee

Model stratigraphy and characteristics developed using geologic information
from B-107+00W, CPT-107+00W, and CPT-108+50E
Topography based on 2007 LiDAR data provided by SCVWD for Project use
Design Water Surface Elevation (Design WSE) provided by SCVWD
All elevations reference North American Vertical Datum of 1988 (NAVD88)

Analysis Section Details
Design WSE - 165.3'

East Levee

Levee Fill
Unit Weight: 115 pcf
Cohesion: 200 psf
Phi: 27 °

Stiffer Fine Grained Alluvium
Unit Weight: 120 pcf
Cohesion: 200 psf
Phi: 30 °

Crest Elevation	166.0'
Crest Width	15.7'
Waterside Slope	2.1H:1V
Waterside Toe Elevation	147.5'
Landside Slope	3.3H:1V
Landside Toe Elevation	159.0'
Factor of Safety	1.99

Softer Fine Grained Alluvium
Unit Weight: 110 pcf
Cohesion: 70 psf
Phi: 27 °

Coarse Grained Alluvium 5% < Fines < 12%
Unit Weight: 140 pcf
Cohesion: 0 psf
Phi: 35 °

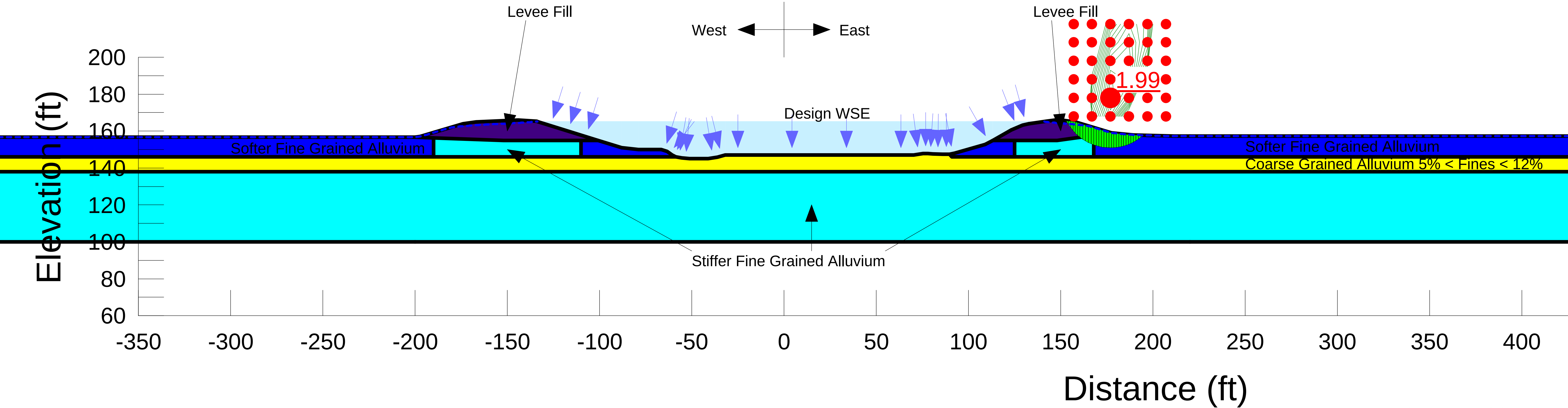


FIGURE F-22

Lower Llagas Creek Capacity Restoration Capital Project

Station 106+50 Rapid Drawdown Stability Analysis - West Levee

Model stratigraphy and characteristics developed using geologic information
from B-107+00W, CPT-107+00W, and CPT-108+50E
Topography based on 2007 LiDAR data provided by SCVWD for Project use
Design Water Surface Elevation (Design WSE) provided by SCVWD
All elevations reference North American Vertical Datum of 1988 (NAVD88)

Analysis Section Details
Design WSE - 165.3'
Winter WSE - 149.0'

West Levee

Levee Fill
Unit Weight: 115 pcf
Cohesion: 200 psf
Phi: 27 °
Drawdown Total Cohesion: 1000 psf
Drawdown Total Phi: 15 °

Stiffer Fine Grained Alluvium
Unit Weight: 120 pcf
Cohesion: 200 psf
Phi: 30 °
Drawdown Total Cohesion: 400 psf
Drawdown Total Phi: 17 °

Softer Fine Grained Alluvium
Unit Weight: 110 pcf
Cohesion: 70 psf
Phi: 27 °
Drawdown Total Cohesion: 100 psf
Drawdown Total Phi: 17 °

Coarse Grained Alluvium 5% < Fines < 12%
Unit Weight: 140 pcf
Cohesion: 0 psf
Phi: 35 °

Crest Elevation	166.0'
Crest Width	34.0'
Waterside Slope	3.2H:1V
Waterside Toe Elevation	145.0'
Landside Slope	3.3H:1V
Landside Toe Elevation	156.7'
Factor of Safety	1.93

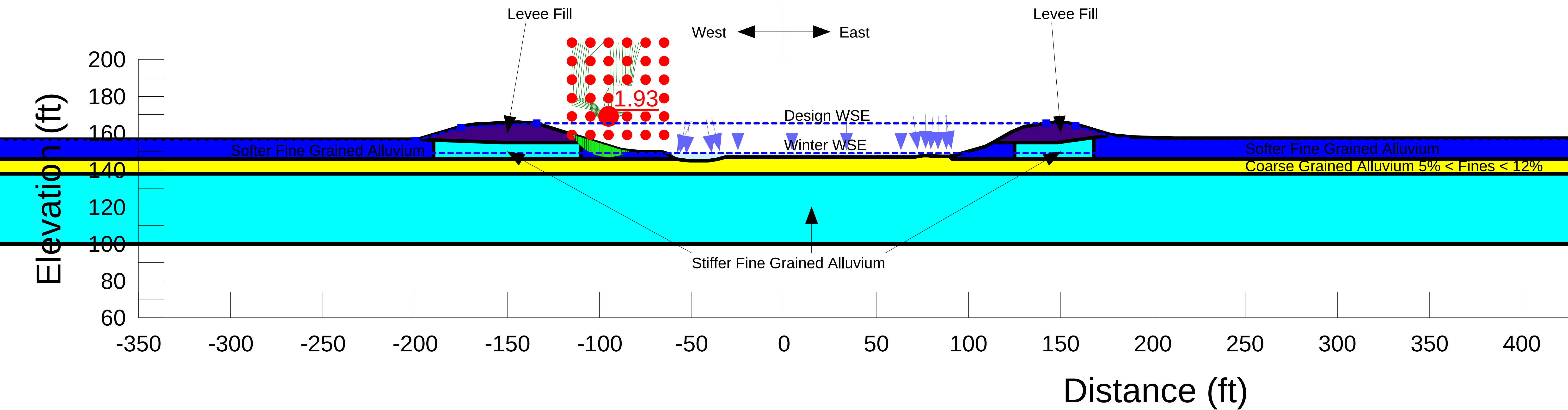


FIGURE F-23

Lower Llagas Creek Capacity Restoration Capital Project

Station 106+50 Rapid Drawdown Stability Analysis - East Levee

Model stratigraphy and characteristics developed using geologic information
from B-107+00W, CPT-107+00W, and CPT-108+50E
Topography based on 2007 LiDAR data provided by SCVWD for Project use
Design Water Surface Elevation (Design WSE) provided by SCVWD
All elevations reference North American Vertical Datum of 1988 (NAVD88)

Analysis Section Details
Design WSE - 165.3'
Winter WSE - 149.0'

East Levee

Levee Fill
Unit Weight: 115 pcf
Cohesion: 200 psf
Phi: 27 °
Drawdown Total Cohesion: 1000 psf
Drawdown Total Phi: 15 °

Stiffer Fine Grained Alluvium
Unit Weight: 120 pcf
Cohesion: 200 psf
Phi: 30 °
Drawdown Total Cohesion: 400 psf
Drawdown Total Phi: 17 °

Crest Elevation	166.0'
Crest Width	15.7'
Waterside Slope	2.1H:1V
Waterside Toe Elevation	147.5'
Landside Slope	3.3H:1V
Landside Toe Elevation	159.0'
Factor of Safety	1.23

Softer Fine Grained Alluvium
Unit Weight: 110 pcf
Cohesion: 70 psf
Phi: 27 °
Drawdown Total Cohesion: 100 psf
Drawdown Total Phi: 17 °

Coarse Grained Alluvium 5% < Fines < 12%
Unit Weight: 140 pcf
Cohesion: 0 psf
Phi: 35 °

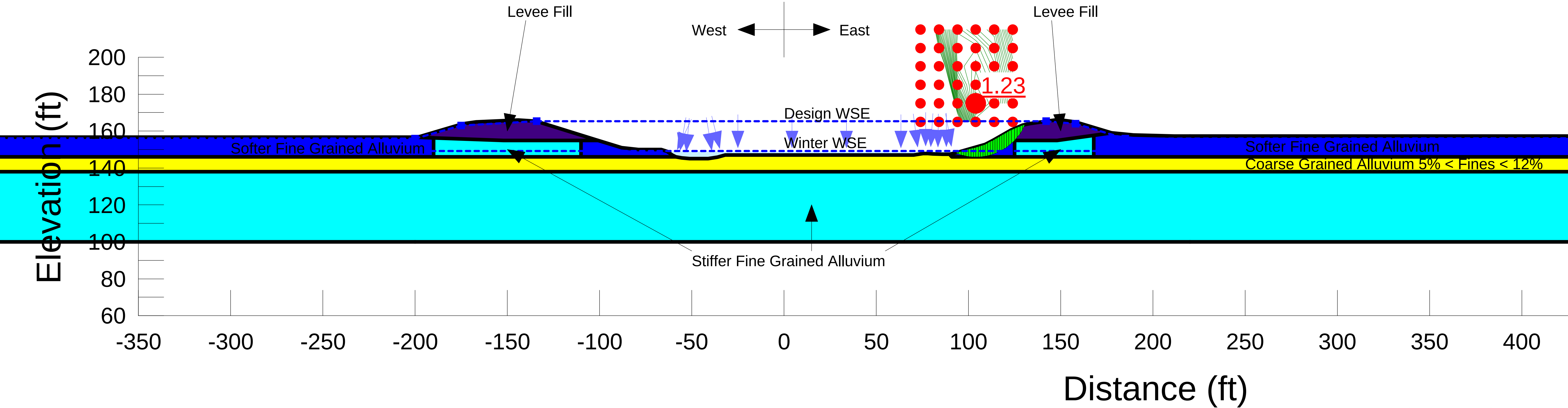


FIGURE F-24

Lower Llagas Creek Capacity Restoration Capital Project

Station 126+00 Steady-State Stability Analysis - East Levee Only

Model stratigraphy and characteristics developed using geologic information
from CPT-126+00E and B-127+00W
Topography based on 2007 LiDAR data provided by SCVWD for Project use
Design Water Surface Elevation (Design WSE) provided by SCVWD
All elevations reference North American Vertical Datum of 1988 (NAVD88)

Analysis Section Details
Design WSE - 169.5'

East Levee

Levee Fill
Unit Weight: 115 pcf
Cohesion: 200 psf
Phi: 27 °

Stiffer Fine Grained Alluvium
Unit Weight: 120 pcf
Cohesion: 200 psf
Phi: 30 °

Coarse Grained Alluvium < 5% Fines
Unit Weight: 140 pcf
Cohesion: 0 psf
Phi: 35 °

Crest Elevation	173.0'
Crest Width	57.6'
Waterside Slope	2.4H:1V
Waterside Toe Elevation	151.0'
Landside Slope	2.1H:1V
Landside Toe Elevation	165.0'
Factor of Safety	2.13

Softer Fine Grained Alluvium
Unit Weight: 110 pcf
Cohesion: 70 psf
Phi: 27 °

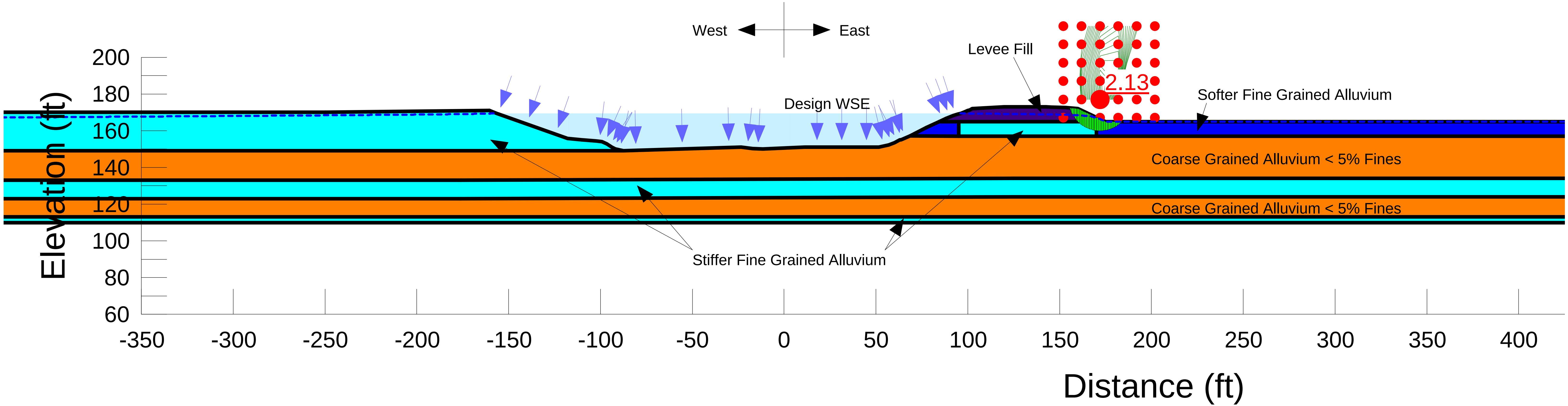


FIGURE F-25

Lower Llagas Creek Capacity Restoration Capital Project

Station 126+00 Rapid Drawdown Stability Analysis - West Levee

Model stratigraphy and characteristics developed using geologic information
from CPT-126+00E and B-127+00W
Topography based on 2007 LiDAR data provided by SCVWD for Project use
Design Water Surface Elevation (Design WSE) provided by SCVWD
All elevations reference North American Vertical Datum of 1988 (NAVD88)

Analysis Section Details
Design WSE - 169.5'
Winter WSE - 153.0'

West Slope

Crest Elevation	171.0'
Crest Width	N/A
Waterside Slope	2.8H:1V
Waterside Toe Elevation	149.0'
Landside Slope	N/A
Landside Toe Elevation	N/A
Factor of Safety	2.29

Levee Fill
Unit Weight: 115 pcf
Cohesion: 200 psf
Phi: 27 °
Drawdown Total Cohesion: 1000 psf
Drawdown Total Phi: 15 °

Stiffer Fine Grained Alluvium
Unit Weight: 120 pcf
Cohesion: 200 psf
Phi: 30 °
Drawdown Total Cohesion: 400 psf
Drawdown Total Phi: 17 °

Coarse Grained Alluvium < 5% Fines
Unit Weight: 140 pcf
Cohesion: 0 psf
Phi: 35 °
Drawdown Total Cohesion: 0 psf
Drawdown Total Phi: 35 °

Softer Fine Grained Alluvium
Unit Weight: 110 pcf
Cohesion: 70 psf
Phi: 27 °
Drawdown Total Cohesion: 100 psf
Drawdown Total Phi: 17 °

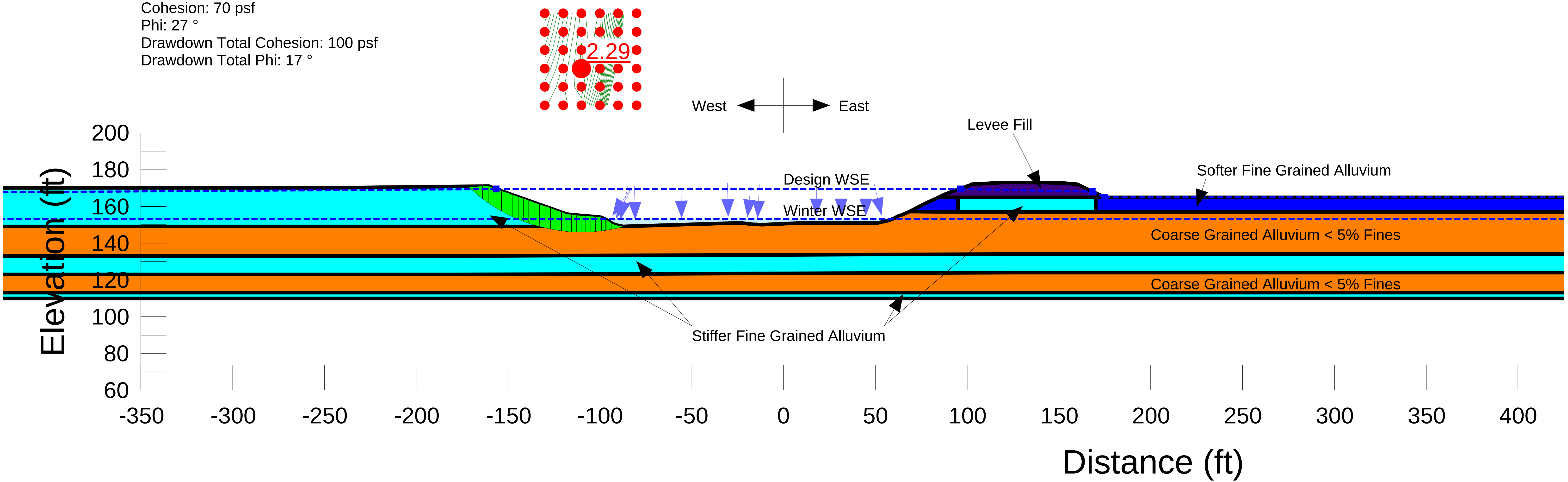


FIGURE F-26

Lower Llagas Creek Capacity Restoration Capital Project

Station 126+00 Rapid Drawdown Stability Analysis - East Levee

Model stratigraphy and characteristics developed using geologic information
from CPT-126+00E and B-127+00W
Topography based on 2007 LiDAR data provided by SCVWD for Project use
Design Water Surface Elevation (Design WSE) provided by SCVWD
All elevations reference North American Vertical Datum of 1988 (NAVD88)

Analysis Section Details

Design WSE - 169.5'
Winter WSE - 153.0'

East Levee

Levee Fill
Unit Weight: 115 pcf
Cohesion: 200 psf
Phi: 27 °
Drawdown Total Cohesion: 1000 psf
Drawdown Total Phi: 15 °

Stiffer Fine Grained Alluvium
Unit Weight: 120 pcf
Cohesion: 200 psf
Phi: 30 °
Drawdown Total Cohesion: 400 psf
Drawdown Total Phi: 17 °

Coarse Grained Alluvium < 5% Fines
Unit Weight: 140 pcf
Cohesion: 0 psf
Phi: 35 °
Drawdown Total Cohesion: 0 psf
Drawdown Total Phi: 35 °

Crest Elevation	173.0'
Crest Width	57.6'
Waterside Slope	2.4H:1V
Waterside Toe Elevation	151.0'
Landside Slope	2.1H:1V
Landside Toe Elevation	165.0'
Factor of Safety	1.36

Softer Fine Grained Alluvium
Unit Weight: 110 pcf
Cohesion: 70 psf
Phi: 27 °
Drawdown Total Cohesion: 100 psf
Drawdown Total Phi: 17 °

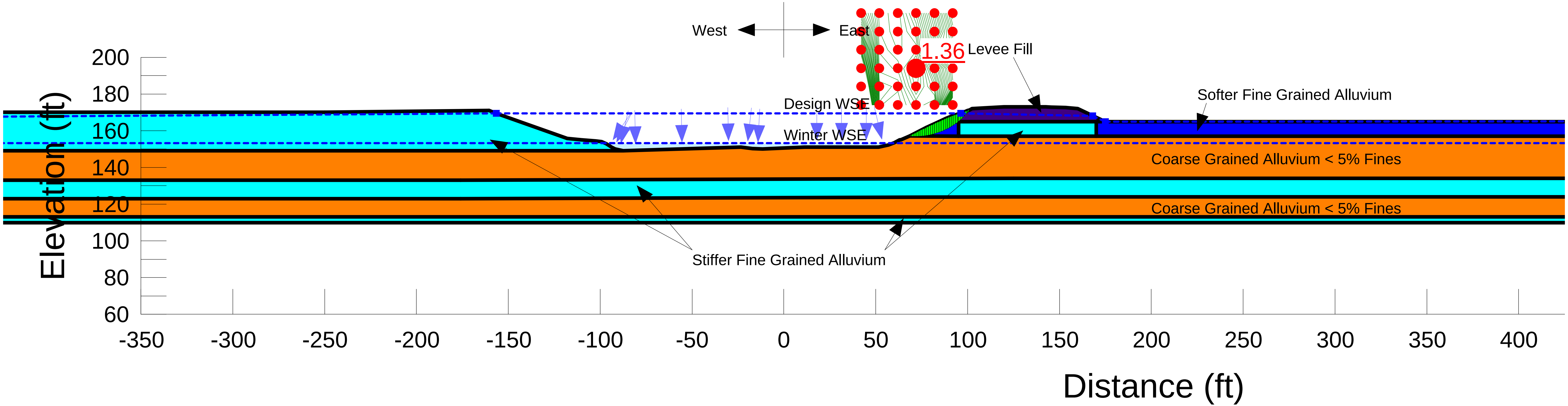


FIGURE F-27

Lower Llagas Creek Capacity Restoration Capital Project

Station 134+00 Rapid Drawdown Stability Analysis - West Levee

Model stratigraphy and characteristics developed using geologic information
from B-132+00W, CPT-132+00W, and B-132+50E
Topography based on 2007 LiDAR data provided by SCVWD for Project use
Design Water Surface Elevation (Design WSE) provided by SCVWD
All elevations reference North American Vertical Datum of 1988 (NAVD88)

Analysis Section Details
Design WSE - 170.8'
Winter WSE - 155.0'

West Slope

Landside Elevation	169.0'
Waterside Slope	1.5H:1V
Waterside Toe Elevation	149.2'
Factor of Safety	1.53

Levee Fill
Unit Weight: 115 pcf
Cohesion: 200 psf
Phi: 27 °
Drawdown Total Cohesion: 1000 psf
Drawdown Total Phi: 15 °

Stiffer Fine Grained Alluvium
Unit Weight: 120 pcf
Cohesion: 200 psf
Phi: 30 °
Drawdown Total Cohesion: 400 psf
Drawdown Total Phi: 17 °

Coarse Grained Alluvium < 5% Fines
Unit Weight: 140 pcf
Cohesion: 0 psf
Phi: 35 °

Artificial Fill
Unit Weight: 115 pcf
Cohesion: 200 psf
Phi: 30 °
Drawdown Total Cohesion: 400 psf
Drawdown Total Phi: 17 °

Coarse Grained Alluvium 5% < Fines < 12%
Unit Weight: 140 pcf
Cohesion: 0 psf
Phi: 35 °

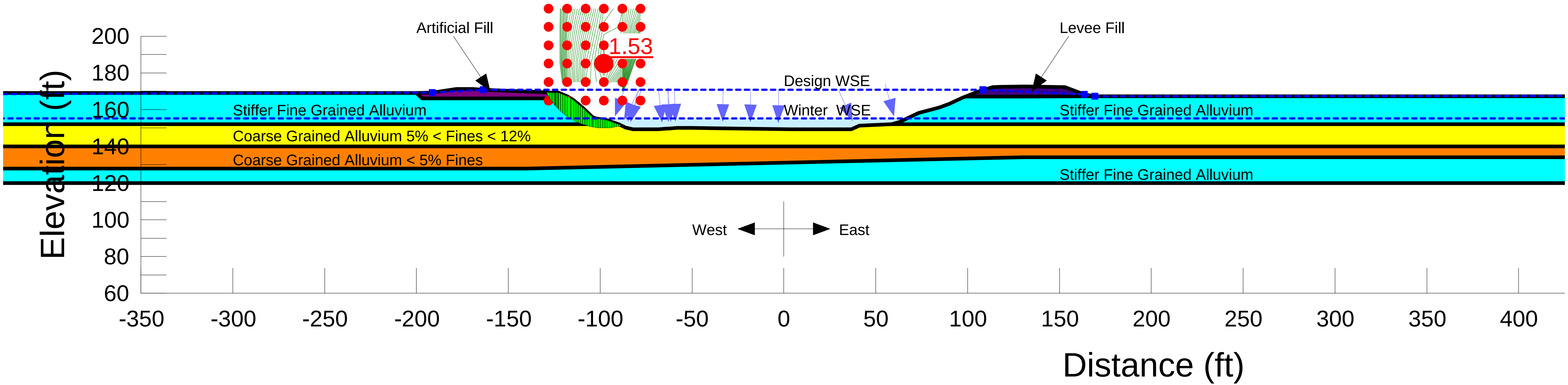

Artificial Fill
1.53
Levee Fill
Design WSE
Winter WSE
Stiffer Fine Grained Alluvium
Stiffer Fine Grained Alluvium
Coarse Grained Alluvium 5% < Fines < 12%
Coarse Grained Alluvium < 5% Fines
Stiffer Fine Grained Alluvium
West
East
200
180
160
140
120
100
80
60
Elevation (ft)
-350
-300
-250
-200
-150
-100
-50
0
50
100
150
200
250
300
350
400
Distance (ft)

FIGURE F-28

Lower Llagas Creek Capacity Restoration Capital Project

Station 134+00 Rapid Drawdown Stability Analysis - East Levee

Model stratigraphy and characteristics developed using geologic information
from B-132+00W, CPT-132+00W, and B-132+50E
Topography based on 2007 LiDAR data provided by SCVWD for Project use
Design Water Surface Elevation (Design WSE) provided by SCVWD
All elevations reference North American Vertical Datum of 1988 (NAVD88)

Analysis Section Details

Design WSE - 170.8'
Winter WSE - 155.0'

East Slope

Levee Fill
Unit Weight: 115 pcf
Cohesion: 200 psf
Phi: 27 °
Drawdown Total Cohesion: 1000 psf
Drawdown Total Phi: 15 °

Stiffer Fine Grained Alluvium
Unit Weight: 120 pcf
Cohesion: 200 psf
Phi: 30 °
Drawdown Total Cohesion: 400 psf
Drawdown Total Phi: 17 °

Coarse Grained Alluvium < 5% Fines
Unit Weight: 140 pcf
Cohesion: 0 psf
Phi: 35 °

Landside Elevation	167.2'
Waterside Slope	2.5H:1V
Waterside Toe Elevation	150.0'
Factor of Safety	2.03

Artificial Fill
Unit Weight: 115 pcf
Cohesion: 200 psf
Phi: 30 °
Drawdown Total Cohesion: 400 psf
Drawdown Total Phi: 17 °

Coarse Grained Alluvium 5% < Fines < 12%
Unit Weight: 140 pcf
Cohesion: 0 psf
Phi: 35 °

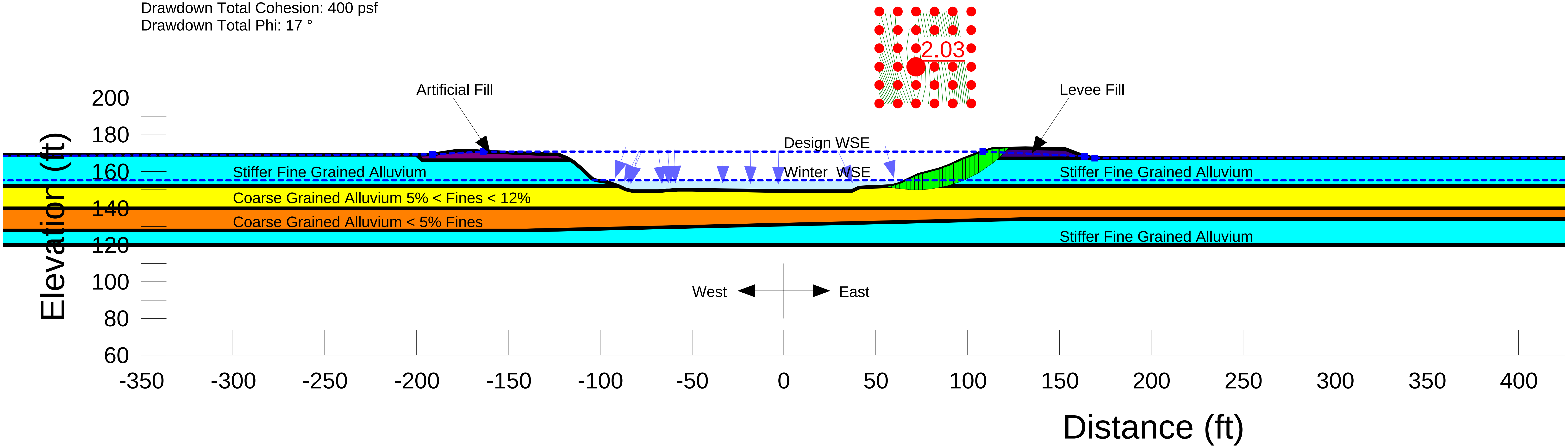

2.03
Artificial Fill
Levee Fill
Design WSE
Winter WSE
Stiffer Fine Grained Alluvium
Stiffer Fine Grained Alluvium
Coarse Grained Alluvium 5% < Fines < 12%
Coarse Grained Alluvium < 5% Fines
Stiffer Fine Grained Alluvium
West
East
200
180
160
140
120
100
80
60
Elevation (ft)
-350
-300
-250
-200
-150
-100
-50
0
50
100
150
200
250
300
350
400
Distance (ft)

FIGURE F-29

Lower Llagas Creek Capacity Restoration Capital Project

Station 166+50 Rapid Drawdown Stability Analysis - West Levee

Model stratigraphy and characteristics developed using geologic information
from CPT-166+75W, B-173+50W, and B-166+50E
Topography based on LiDAR data provided by SCVWD for Project use
Design Water Surface Elevation (Design WSE) provided by SCVWD
All elevations reference North American Vertical Datum of 1988 (NAVD88)

Analysis Section Details
Design WSE - 177.8'
Winter WSE - 164.0'

West Slope

Artificial Fill
Unit Weight: 115 pcf
Cohesion: 200 psf
Phi: 30 °
Drawdown Total Cohesion: 400 psf
Drawdown Total Phi: 17 °

Coarse Grained Alluvium > 12% Fines
Unit Weight: 120 pcf
Cohesion: 0 psf
Phi: 32 °

Coarse Grained Alluvium < 5% Fines
Unit Weight: 140 pcf
Cohesion: 0 psf
Phi: 35 °

Landside Elevation	180.0'
Waterside Slope	2.4H:1V
Waterside Toe Elevation	160.0'
Factor of Safety	1.91

Stiffer Fine Grained Alluvium
Unit Weight: 120 pcf
Cohesion: 200 psf
Phi: 30 °
Drawdown Total Cohesion: 400 psf
Drawdown Total Phi: 17 °

Coarse Grained Alluvium < 5% Fines <12%
Unit Weight: 140 pcf
Cohesion: 0 psf
Phi: 35 °

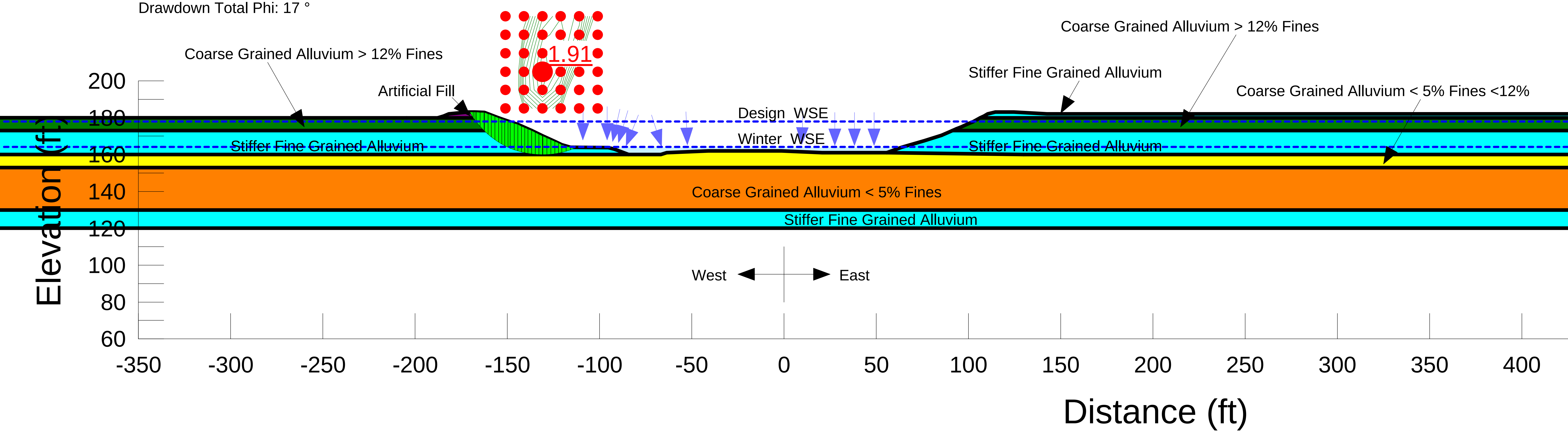


FIGURE F-30

Lower Llagas Creek Capacity Restoration Capital Project

Station 166+50 Rapid Drawdown Stability Analysis - East Levee

Model stratigraphy and characteristics developed using geologic information
from CPT-166+75W, B-173+50W, and B-166+50E
Topography based on LiDAR data provided by SCVWD for Project use
Design Water Surface Elevation (Design WSE) provided by SCVWD
All elevations reference North American Vertical Datum of 1988 (NAVD88)

Analysis Section Details

Design WSE - 177.8'
Winter WSE - 164.0'

East Slope

Landside Elevation	182.0'
Waterside Slope	2.2H:1V
Waterside Toe Elevation	161.0'
Factor of Safety	1.84

Artificial Fill
Unit Weight: 115 pcf
Cohesion: 200 psf
Phi: 30 °
Drawdown Total Cohesion: 400 psf
Drawdown Total Phi: 17 °

Coarse Grained Alluvium > 12% Fines
Unit Weight: 120 pcf
Cohesion: 0 psf
Phi: 32 °

Coarse Grained Alluvium < 5% Fines
Unit Weight: 140 pcf
Cohesion: 0 psf
Phi: 35 °

Stiffer Fine Grained Alluvium
Unit Weight: 120 pcf
Cohesion: 200 psf
Phi: 30 °
Drawdown Total Cohesion: 400 psf
Drawdown Total Phi: 17 °

Coarse Grained Alluvium < 5% Fines <12%
Unit Weight: 140 pcf
Cohesion: 0 psf
Phi: 35 °

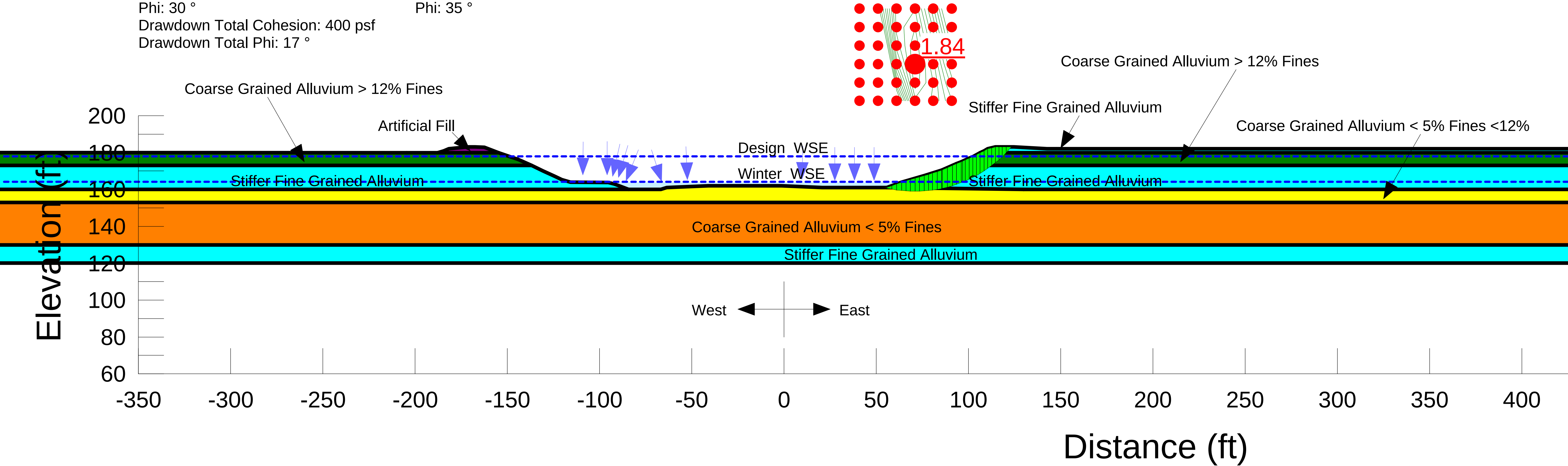

1.84
Coarse Grained Alluvium > 12% Fines
Artificial Fill
Coarse Grained Alluvium > 12% Fines
Stiffer Fine Grained Alluvium
Coarse Grained Alluvium < 5% Fines <12%
Design WSE
Winter WSE
Stiffer Fine Grained Alluvium
Stiffer Fine Grained Alluvium
Coarse Grained Alluvium < 5% Fines
Stiffer Fine Grained Alluvium
West
East
200
180
160
140
120
100
80
60
Elevation (ft)
-350
-300
-250
-200
-150
-100
-50
0
50
100
150
200
250
300
350
400
Distance (ft)

FIGURE F-31

Attachment 1 – Fine Grained Shear Strengths

Evaluation of Fine Grained Soil Shear Strengths

Purpose:

Select representative strength parameter values for fine grained soils for slope stability analyses.

References:

(1) Soil Conservation Service (1973), Revised Geologic Profile – Lower Llagas WPP Unit L-1 Sta. 0+00 to 200+00, August 17.
(2) Ladd, C.C. and Foott, R. (1974), New Design Procedure for Stability of Soft Clays, Journal of the Geotechnical Engineering Division, ASCE vol. 99, GT7, pg. 763-786.
(3) Duncan et al,1989, Shear Strength Correlations for Geotechnical Engineering, August.
(4) Kulhawy, F. and Mayne, P., 1990, Manual on Estimating Soil Properties for Foundation Design, Electrical Power Research Institute, August.
(5) URS, Inc., 2011, Guidance Document for Geotechnical Analyses: Urban Levee Geotechnical Evaluations Program, Revision 10, Department of Water Resources, State of California, September.

Approach:

Fine grained soils modeled for slope stability analyses include the Levee Fill, Loose Levee Fill, Artificial Fill, New Levee Fill, Softer Fine Grained Alluvium, and Stiffer Fine Grained Alluvium. The process for evaluating shear strength for the fine grained soils is described below.

Fine Grained Soils:

Shear strengths for the fine grained soils evaluated were estimated from empirical correlations to plasticity index, laboratory Unconfied Compression (UC) tests, Unconsolidated Undrained (UU) triaxial tests, Consolidated Undrained (CU) triaxial tests with pore pressure measurements from samples recovered during site the investigation, previous Vane Shear Tests (VST) (Soil Conservation Service 1973), and SHANSEP (Ladd and Foott 1974) curves based on consolidation tests from samples taken during the site investigation.

The Loose Levee Fill, which was placed between Stations 47+00 and 62+00 in Reach 1, comes from the same source as the Levee Fill, but was not placed to the same degree of compaction. Therefore, the strength parameters for the Loose Levee Fill were estimated as reduced values of the Levee Fill strength parameters.

The Artificial Fill found on the west side of the channel at analyses for Stations 134+00 and 166+50 has a similar USCS description and index properties to the Stiffer Fine Grained Alluvium. Therefore, the strength parameters for the Artificial Fill were estimated as equal to the values of the Stiffer Fine Grained Alluvium strength parameters.

One possible remediation for freeboard deficiencies is to place additional fill. The additional fill was assumed to have similar properties to the current Levee Fill. Therefore, the New Levee Fill, will have strength parameters equal to the Levee Fill. The New Levee Fill was only analyzed for the end-of-construction slope stability analyses.

Fine Grained Shear Strengths

Index and Moisture-Density Test Results

Index test and moisture-density test data from representative materials are summarized in the table below.

Material	USCS	LL	PL	PI Range	Avg. PI	Avg. % Passing #200 Sieve	Avg. Moisture Content (%)	Avg. Dry Density (pcf)
Levee Fill	CH	60	23	22 to 48	36	~95	22	98
Softer Fine Grained Alluvium	CH/CL	69	29	14 to 61	40	~85	49	73
Stiffer Fine Grained Alluvium	CL/CH/ML	50	21	19 to 43	29	~63	27	96

UC Test Results

Cooper Testing Laboratories performed 18 laboratory UC tests. Eleven tests were performed on Levee Fill, three tests were performed on Softer Fine Grained Alluvium, and four tests were performed on Stiffer Fine Grained Alluvium. For each test, we estimated the undrained shear strength at 5% strain to assist in developing an undrained strength envelope and strength values used for rapid drawdown, end-of-construction, and seismic slope stability analyses.

Summaries of the UC tests are shown in Appendix C.

UU Test Results

Cooper Testing Laboratories performed 12 laboratory UU tests. One test was performed on Levee Fill, four tests were performed on Softer Fine Grained Alluvium, and seven tests were performed on Stiffer Fine Grained Alluvium. For each test, we estimated the undrained shear strength at 5% strain to assist in developing an undrained strength envelope and strength values used for rapid drawdown, end-of-construction, and seismic slope stability analyses.

Summaries of the UU tests are shown in Appendix C.

CU Test Results

Cooper Testing Laboratories performed four sets of 3-point laboratory CU tests with pore pressure measurements on undisturbed Shelby tube samples. One test was performed on Levee Fill, two tests were performed on Softer Fine Grained Alluvium, and one test was performed on Stiffer Fine Grained Alluvium. Stresses at failure were evaluated for all data sets. For each soil type, the failure data at 5% strain were used with other data to determine a drained strength envelope and an undrained strength envelope for steady-state and rapid-drawdown analyses, respectively.

Summaries of each set of CU tests with pore pressure measurements are shown in Appendix C.

Client: Santa Clara Valley Water District
Project: Lower Llagas Creek Capacity Restoration Capital Project
Project No.: 11540-0
Prepared By: T. Haynes
Date: 5/17/2012
Checked By: L. Sansone
Date: 6/1/2012

Fine Grained Shear Strengths

Drained Strength Envelope

The drained strength envelope, also known as the S-Envelope, was used for steady-state and rapid-drawdown slope stability analyses. Drained strengths were estimated from empirical correlations to plasticity index and plotting the results along with the drained shear strength and confining stress at 5% strain from the CU tests. The empirical correlations assume the soil is normally consolidated, therefore, the soil will not have an effective cohesion. Effective cohesion for overconsolidated soils was estimated from the CU data and the approach to estimating effective cohesion outlined by URS (2011).The data were then fit with a design failure envelope. The design drained failure envelope for the Levee Fill and Fine Grained Alluvium are attached.

Undrained Strength Envelope

The undrained strength envelope, also known as the R-Envelope, was used for the rapid drawdown, end-of-construction, and seismic slope stability analyses. Undrained strengths were determined by plotting the Unconfined Compression test results, the UU test results, the undrained shear strength and confining stress at 5% strain results from the CU tests, and a SHANSEP curve. The equation for the SHASEP curve is presented below:

$$S_u = S \text{ x } \sigma'_{v0} \text{ x } (\sigma'_p/\sigma'_{v0})^m$$

where:

S_u is the undrained shear strength,
S is the normalized strength ratio for normally consolidated soil; estimated to be 0.3 (Ladd 1991),
σ'_{v0} is the in-situ vertical effective stress,
σ'_p is the maximum past pressure, and
m is an empirical constant (typical range of 0.75 to 0.85 for most cohesive soils); estimated to be 0.8.

The maximum past pressure for Levee Fill, 7,500 psf, was based on the highest value obtained from the consolidation tests on Stiffer Fine Grained Alluvium. The maximum preconsolidation stress for Softer Fine Grained Alluvium, 3,000 psf, was based on three consolidation test results on Softer Fine Grained Alluvium. The maximum preconsolidation stress for Stiffer Fine Grained Alluvium, 5,000 psf, was based on the lower value obtained from the two consolidation tests on Stiffer Fine Grained Alluvium. The UC test results, the UU test results, the undrained CU test results, and SHANSEP curve were fit with a design strength envelope. The data and the design undrained strength envelope for the Levee Fill, Softer Fine Grained Alluvium, and Stiffer Fine Grained Alluvium are attached.

The design undrained strength envelope was used to assign undrained shear strength values (ϕ=0) for the end-of-construction and seismic slope stability analyses. The undrained strength values were estimated by inputting the average overburden at the mid-point of the layer into the design strength envelope. The estimated undrained shear strength value was compared to average CPT strength values, and CU and UU test results. The undrained strength values used for the end-of-construction stability analyses are presented in **Table F-1**, where the end-of-construction stability case was performed for the section at Station 50+00. The undrained strength value was reduced by 20% for seismic slope stability analyses described in Appendix G.

GEI Consultants

Client: Santa Clara Valley Water District
Project: Lower Llagas Creek Capacity Restoration Capital Project
Project No.: 11540-0
Prepared By: T. Haynes
Date: 5/17/2012
Checked By: L. Sansone
Date: 6/1/2012

Fine Grained Shear Strengths

Summary:

Shear strength envelopes for the materials in the embankment are summarized below:

Material	Unit Weight (pcf)	Effective Stress Envelope		Total Stress Envelope	
		c' (psf)	ϕ' (deg)	c (psf)	ϕ (deg)
Levee Fill	115	200	27	1000	15
Loose Levee Fill	110	50	27	500	15
Artificial Fill	120	200	30	400	17
Softer Fine Grained Alluvium	110	70	27	100	17
Stiffer Fine Grained Alluvium	120	200	30	400	17

Attachments:

Attachment 1-1	Figure 4-20 ϕ'_{cv} for NC Clays versus PI
Attachment 1-2	Figure 42 Correlation between ϕ' at $(\sigma_1/\sigma_3)_{max}$ and I_p from Triaxial Tests on Normally Consolidated Clays
Attachment 1-3	Levee Fill Drained Strength
Attachment 1-4	Fine Grained Alluvium Drained Strengths
Attachment 1-5	Levee Fill Undrained Strength
Attachment 1-6	Softer Fine Grained Alluvium Undrained Strength
Attachment 1-7	Stiffer Fine Grained Alluvium Undrained Strength

Attachment 1-1
Figure 4-20 ϕ'_{cv} for NC Clays versus PI

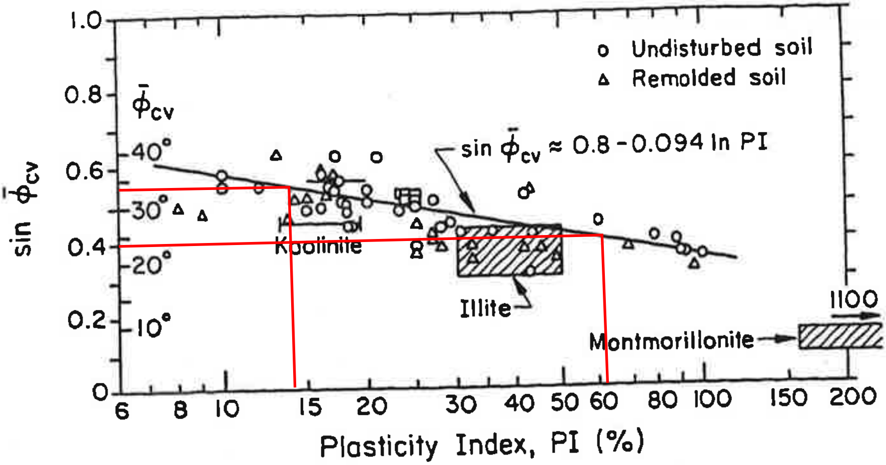


Figure 4-20. $\bar{\phi}_{cv}$ for NC Clays versus PI

Source: Mitchell (22), p. 284.

Attachment 1-2

Figure 42 Correlation between ϕ' at $(\sigma_1/\sigma_3)_{max}$ and I_p from Triaxial Tests on Normally Consolidated Clays

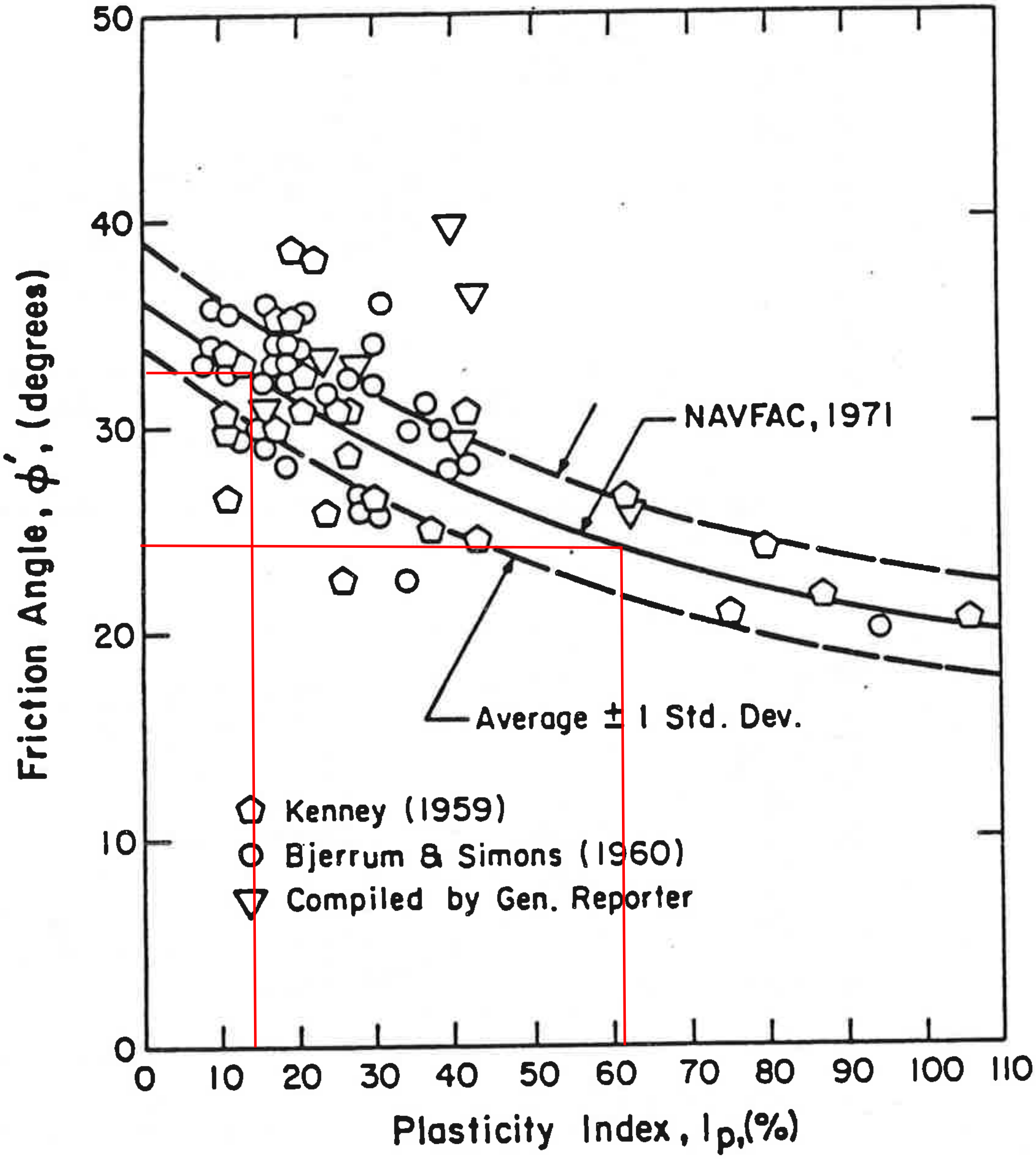
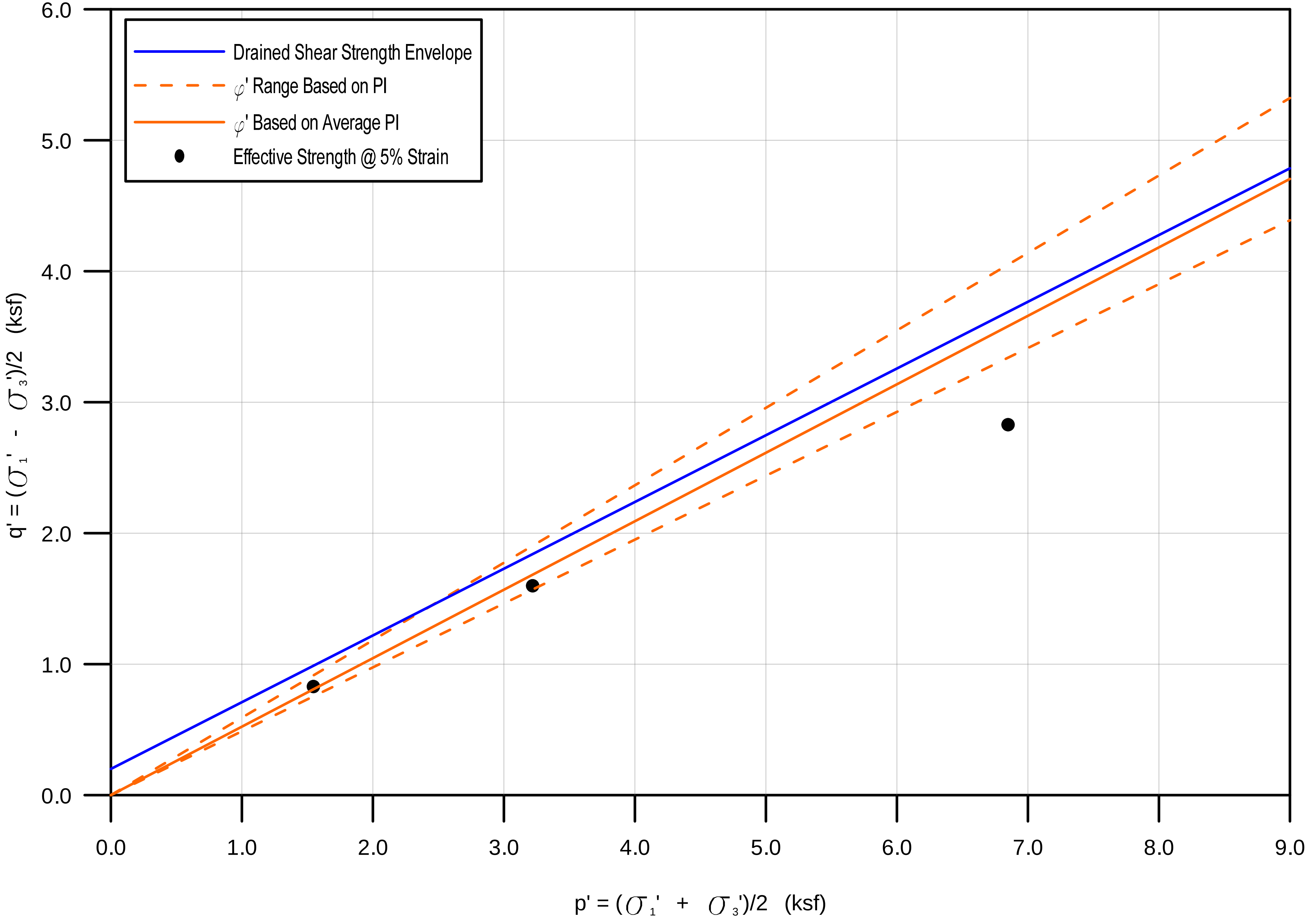


Fig. 42 Correlation between ϕ' at $(\sigma_1/\sigma_3)_{max}$ and I_p from Triaxial Tests on Normally Consolidated Clays, (After Ladd et al, 1977).

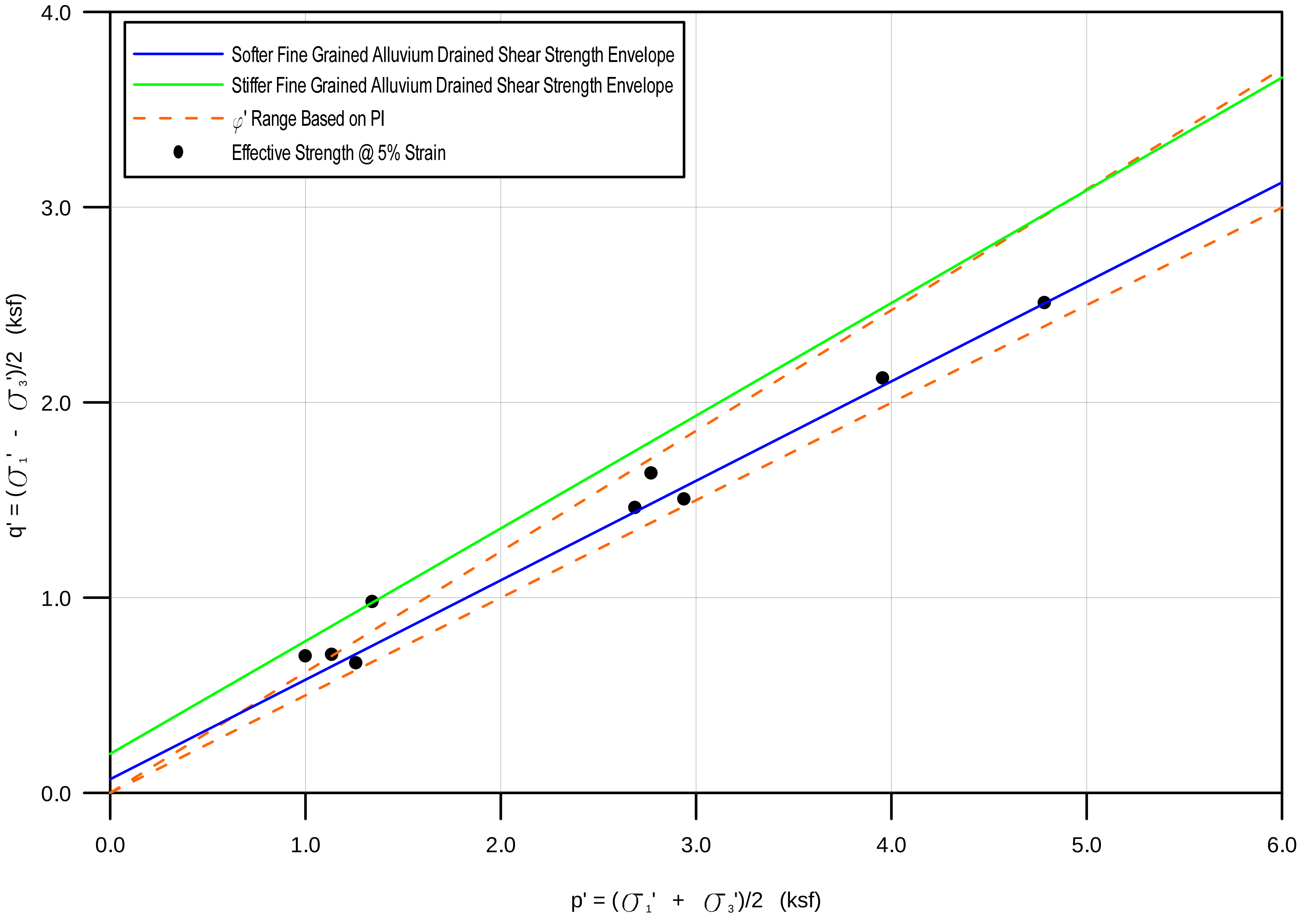
Attachment 1-3
Levee Fill Drained Strength

Levee Fill Drained Shear Strength



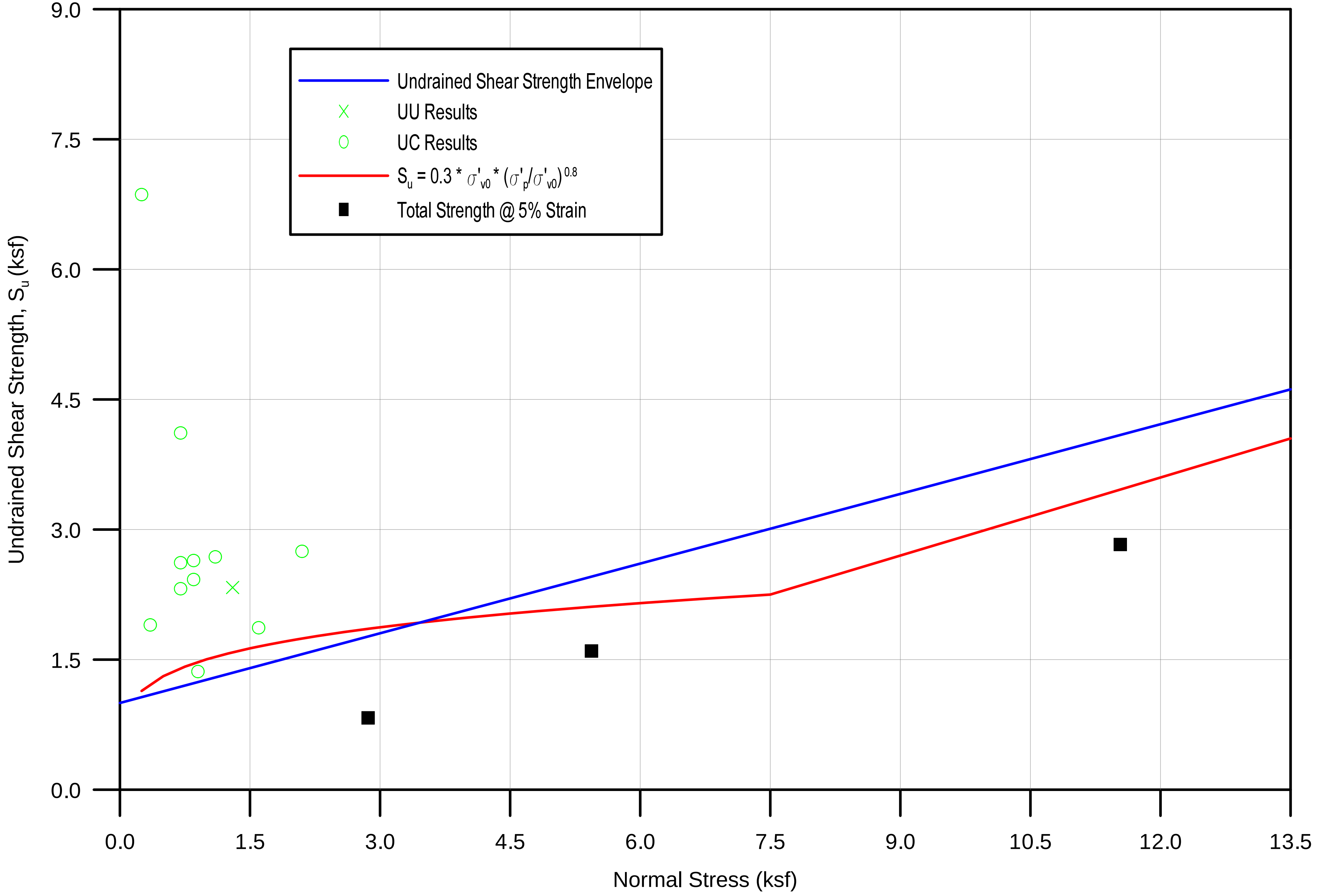
Attachment 1-4
Fine Grained Alluvium Drained Strengths

Fine Grained Alluvium Drained Shear Strengths



Attachment 1-5
Levee Fill Undrained Strength

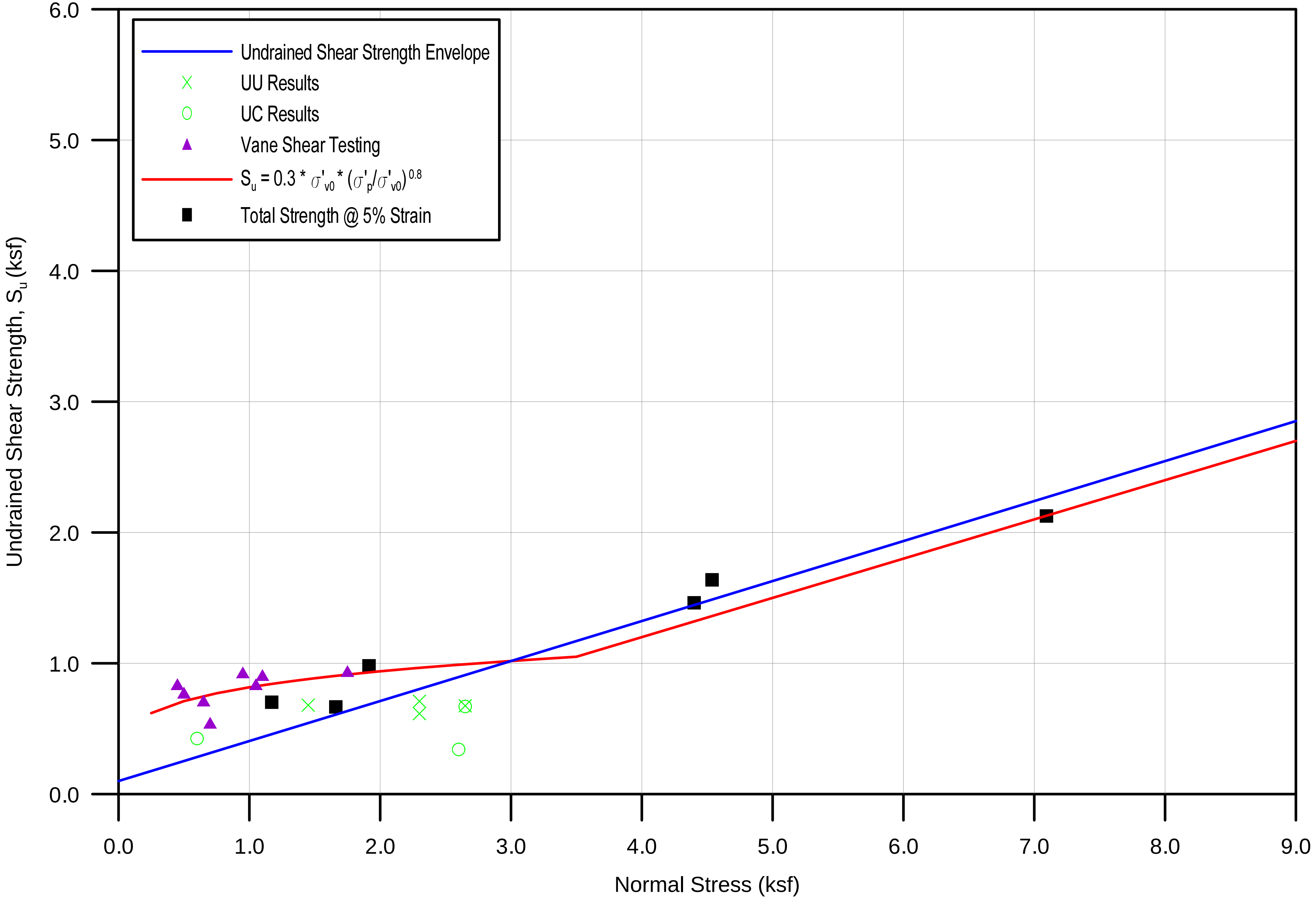
Levee Fill Undrained Shear Strength



Attachment 1-6

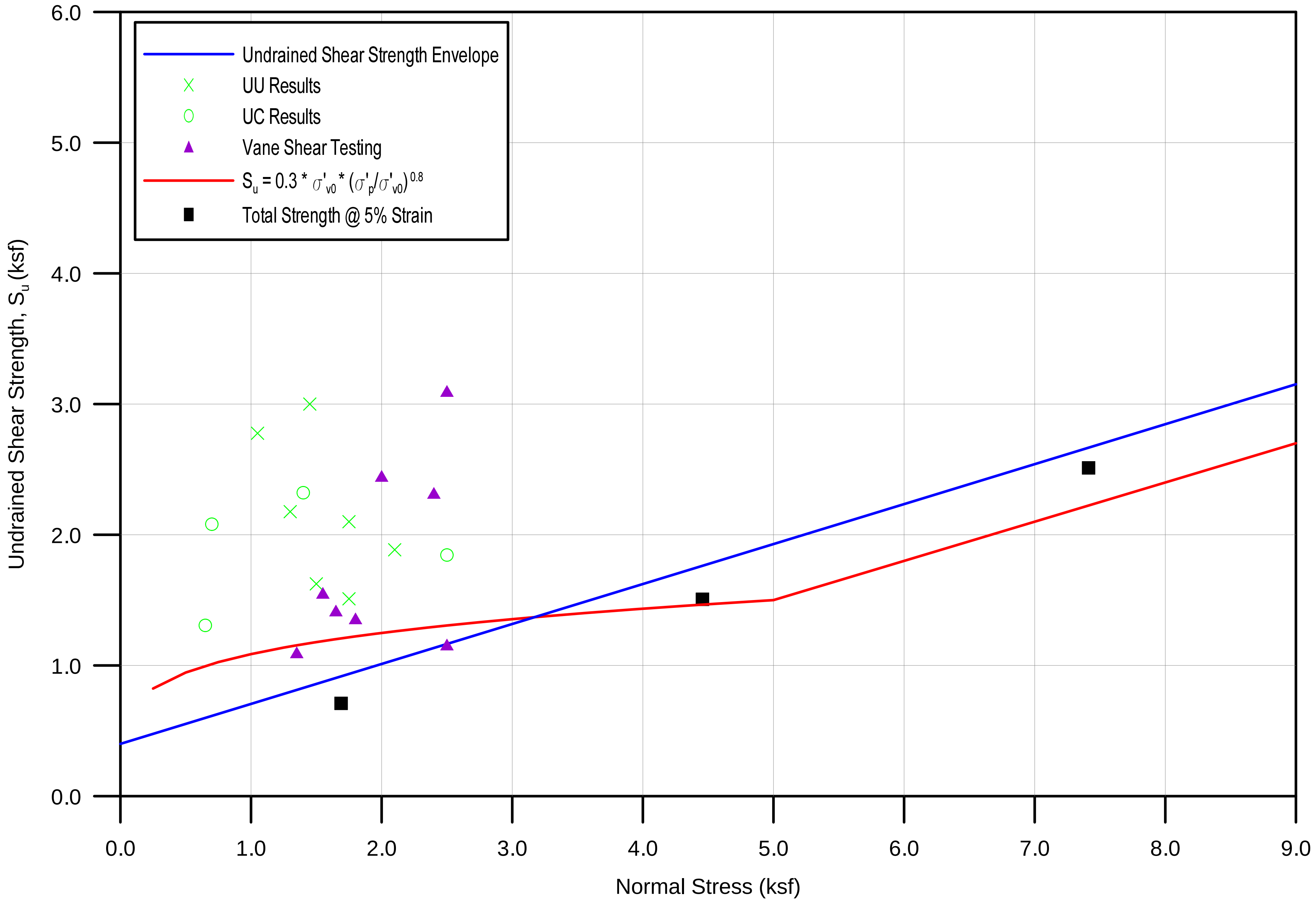
Softer Fine Grained Alluvium Undrained Strength

Softer Fine Grained Alluvium Undrained Shear Strength



Attachment 1-7
Stiffer Fine Grained Alluvium Undrained Strength

Stiffer Alluvium Undrained Shear Strength



Attachment 2 – Peat Shear Strengths

Evaluation of Peat Shear Strengths

Purpose:

Select representative strength parameter values for the peats for slope stability analysis.

References:

(1) Ladd, C.C. and Foott, R. (1974), New Design Procedure for Stability of Soft Clays, Journal of the Geotechnical Engineering Division, ASCE vol. 99, GT7, pg. 763-786.
(2) Soil Conservation Service (1973), Revised Geologic Profile – Lower Llagas WPP Unit L-1 Sta. 0+00 to 200+00, August 17.
(3) GEI Consultants, Inc (2009), Twitchell Island Levee Improvement Project, San Joaquin River Reach, January.
(4) Mesri, G. and Ajlouni, M. (2007), Engineering Properties of Fibrous Peats, Journal of Geotechnical and Geoenvironmental Engineering, ASCE, Vol. 133, No. 7, pg. 850-866.
(5) Ladd, C.C. (1991), Stability Evaluation During Staged Construction, ASCE Journal of Geotechnical Engineering, Vol. 117, No. 4, pg. 540-615.

Approach:

The process for evaluating shear strength for peats is described below.

Peats:

Peat soils generally underlie the Levee Fill or Fine Grained Alluvial Soils. Shear strengths for Peat soils were estimated from published values, laboratory Unconsolidated Undrained (UU) triaxial tests from samples tested during the site investigations, previous Vane Shear Tests (VST) (Soil Conservation Service 1973), and a SHANSEP (Ladd and Foott 1974) curve based on maximum past pressure estimates determined from consolidation tests from samples from Twitchell Island (GEI 2009).

Index and Moisture-Density Test Results

Index test and moisture-density test data from representative materials from the recent exploration program are summarized in the table below.

Material	Avg. % Organic Content	Avg. Moisture Content (%)	Avg. Dry Density (pcf)
Peat	52.5	223	21

UU Test Results

Cooper Testing Laboratories performed two laboratory UU tests on Peat soils in 2012. For each test, we estimated the undrained shear strength at 5% strain to assist in developing an undrained strength envelope used for rapid drawdown, end-of-construction, and seismic slope stability analyses.

Summaries of the UU tests are shown in Appendix C.

Drained Strength Envelope

The drained strength envelope, also known as the S-Envelope, was used for steady-state slope stability analyses. The effective friction angle was estimated using published values (Mesri and Ajlouni 2007). Since no laboratory strength testing under drained conditions was performed, the value for the effective friction angle was reduced for analysis purposes.

Undrained Strength Envelope

The undrained strength envelope, also known as the R-Envelope, was used for the rapid drawdown, end-of-construction, and seismic slope stability analyses. Undrained strengths were determined by plotting the UU test results, the VST results, and a SHANSEP curve. The equation for the SHASEP curve is presented below:

$$S_u = S \times \sigma'_{v0} \times (\sigma'_p/\sigma'_{v0})^m$$

where:

S_u is the undrained shear strength,
S is the normalized strength ratio for normally consolidated soil; estimated to be 0.3 (Ladd 1991),
σ'_{v0} is the in-situ vertical effective stress,
σ'_p is the maximum past pressure, and
m is an empirical constant (typical range of 0.75 to 0.85 for most cohesive soils); estimated to be 0.3.

The maximum past pressure, 1,000 psf, was based on consolidation tests from samples from Twitchell Island (GEI 2009). The UU test results, VST results, and SHANSEP curve were fit with a design strength envelope. The data and the design strength envelope are attached.

The design undrained strength envelope was used to assign undrained shear strength values (ϕ=0) for the end-of-construction and seismic slope stability analyses. The undrained strength values were estimated by inputting the average overburden at the mid-point of the layer into the design strength envelope. The estimated undrained shear strength value was compared to average CPT strength values, and CU and UU test results. The undrained strength values used for the end-of-construction stability analyses are presented in **Table F-1**, where the end-of-construction stability case was performed for the section at Station 50+00. The undrained strength value was reduced by 20% for seismic slope stability analyses described in Appendix G.

Summary:

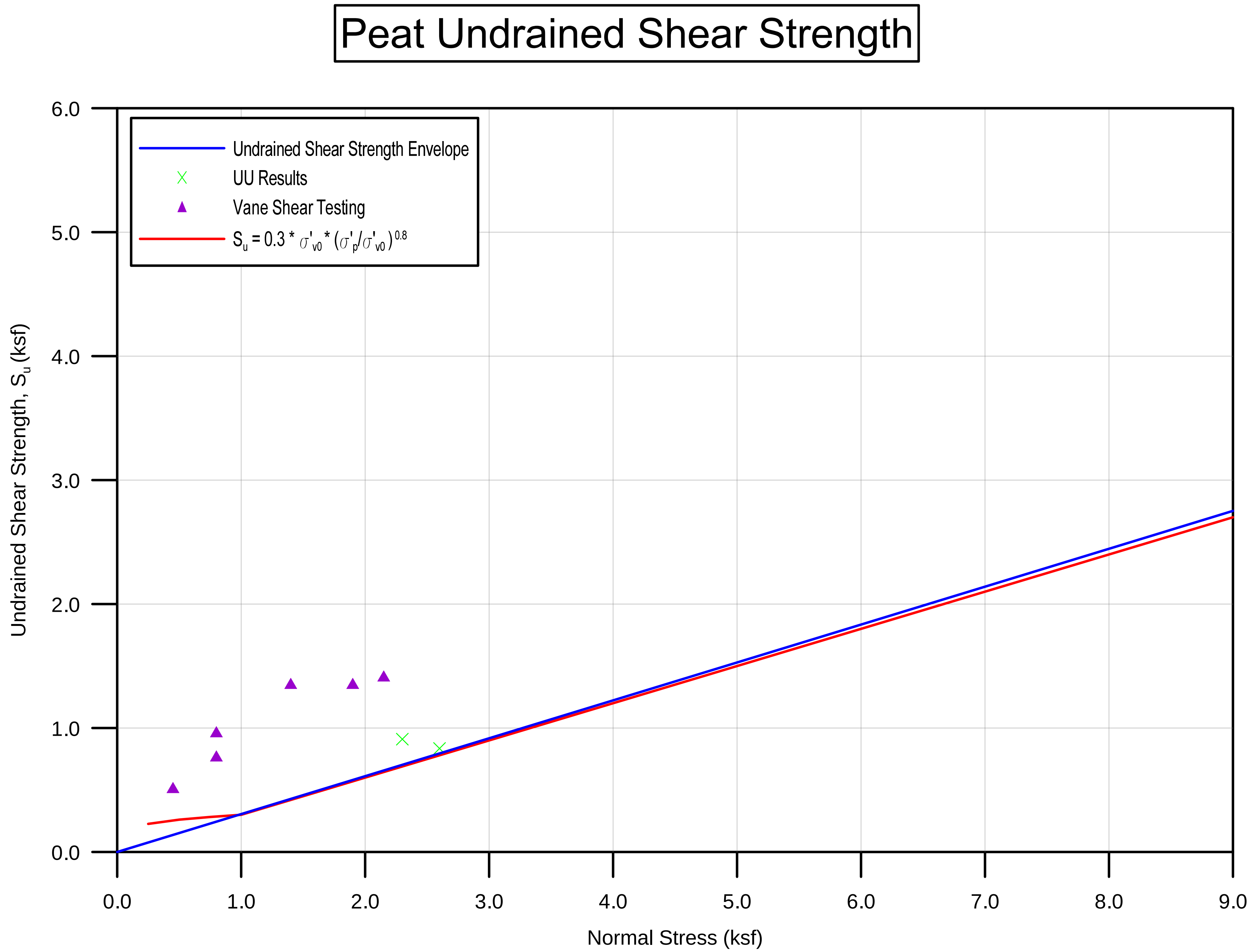
Shear strengths for peats are summarized below:

Material	Unit Weight (pcf)	Drained Strength Envelope		Undrained Strength Envelope	
		c' (psf)	ϕ' (deg)	c (psf)	ϕ (deg)
Peat	70	0	30	0	17

Attachments:

Attachment 2-1 Peat Undrained Shear Strength

Attachment 2-1
Peat Undrained Shear Strength


Peat Undrained Shear Strength
Undrained Shear Strength Envelope
UU Results
Vane Shear Testing
$S_u = 0.3 * \sigma'_{v0} * (\sigma'_p/\sigma'_{v0})^{0.8}$
Undrained Shear Strength, S_u (ksf)
6.0
5.0
4.0
3.0
2.0
1.0
0.0
0.0
1.0
2.0
3.0
4.0
5.0
6.0
7.0
8.0
9.0
Normal Stress (ksf)

Attachment 3 – Coarse Grained Shear Strengths

Evaluation of Coarse Grained Shear Strengths

Purpose:

Select representative strength parameter values for the Existing Coarse Grained soils for slope stability analysis.

References:

(1) Duncan et al,1989, Shear Strength Correlations for Geotechnical Engineering, August.
(2) Kulhawy, F. and Mayne, P., 1990, Manual on Estimating Soil Properties for Foundation Design, Electrical Power Research Institute, August.
(3) Naval Facilities Engineering Command (NAVFAC), 1982, Foundations and Earth Structures, Design Manual 7.2, September.

Approach:

Coarse grained soils encountered were alluvial and separated into the following three categories: Coarse Grained Alluvium with greater than 12% fines, Coarse Grained Alluvium with more than 5%, but less than 12% fines, and Coarse Grained Alluvium with less than 5% fines. The process for evaluating shear strength for coarse grained soils is described below.

Coarse Grained Alluviual Soils:

The Coarse Grained Alluvial Soils generally underlie Fine Grained Alluvial Soils. Shear strengths for the Coarse Grained Alluvial Soils were estimated from empirical correlations and published values.

Blow Count Data

Standard Penetration Test blow count data from representative materials are summarized in the table below.

Material	USCS	Blow Count Range, N	Avg. Blow Count, N_{avg}	N/σ'_{vo} Range (kg/cm^2)	Avg. N/σ'_{vo} (kg/cm^2)
Coarse Grained Alluvium > 12% Fines	SM/SC	10 to 26	18	12 to 26	16
Coarse Grained Alluvium > 5% Fines < 12%	SP-SM/ GP-GM	23 to Refusal	61	15 to Refusal	34
Coarse Grained Alluvium < 5% Fines	SP/GP	24 to Refusal	73	22 to Refusal	35

σ'_{vo} is the in-situ vertical effective stress at the sample depth

Drained Strength Envelope

The drained strength envelope, also known as the S-Envelope, was used for steady-state, rapid drawdown, end-of-construction, and seismic, for non-liquefied soils, slope stability analyses. The effective friction angle was estimated using empirical correlations (Kulhawy and Mayne 1991 and Duncan et al. 1989) and published values (NAVFAC DM 7.2 1982). Since a downhole hammer was used to collect samples and no laboratory strength testing was performed, the empirical values were reduced for analysis purposes.

GEI Consultants

Client: Santa Clara Valley Water District
Project: Lower Llagas Creek Capacity Restoration Capital Project
Project No.: 11540-0
Prepared By: T. Haynes
Date: 5/172012
Checked By: Len Sansone
Date: 6/1/2012

Coarse Grained Shear Strengths

Undrained Strength Envelope

The undrained strength envelope for coarse grained soils were not estimated since excess pore pressures dissipate quickly in coarse grained soils, and undrained conditions are not expected to occur under rapid drawdown or seismic loading conditions.

Summary:

Shear strengths for the materials in the embankment are summarized below:

Material	Unit Weight (pcf)	Drained Strength Envelope	
		c' (psf)	ϕ' (deg)
Coarse Grained Alluvium > 12% Fines	120	0	32
Coarse Grained Alluvium 5% < Fines <12%	140	0	35
Coarse Grained Alluvium < 5% Fines	140	0	35

Attachments:

Attachment 3-1	Figure 4-12 N versus ϕ'_{tc}
Attachment 3-2	Relationship between Angle of Internal Friction of Cohesionless Soils and SPT Blow Count
Attachment 3-3	Relationbetween ϕ' and N/σ'_{vo}
Attachment 3-4	NAVFAC DM 7.2 Table 1 Typical Properties of Compacted Soils

Attachment 3-1

Figure 4-12 N versus ϕ'_{tc}

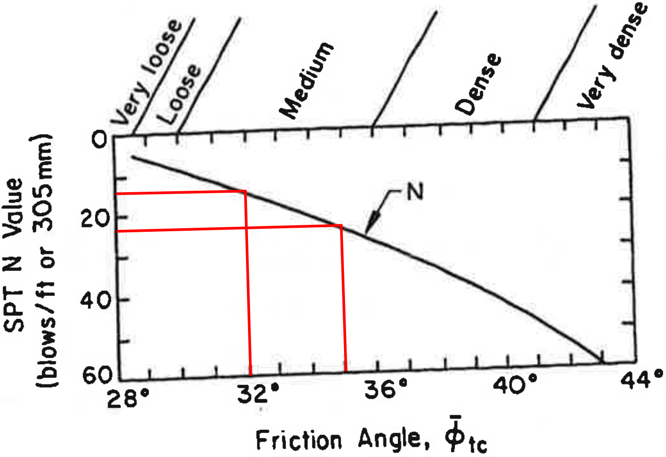


Figure 4-12. N versus $\bar{\phi}_{tc}$

Source: Peck, Hanson, and Thornburn (12), p. 310.

Attachment 3-2

Relationship between Angle of Internal Friction of Cohesionless Soils and SPT Blow Count

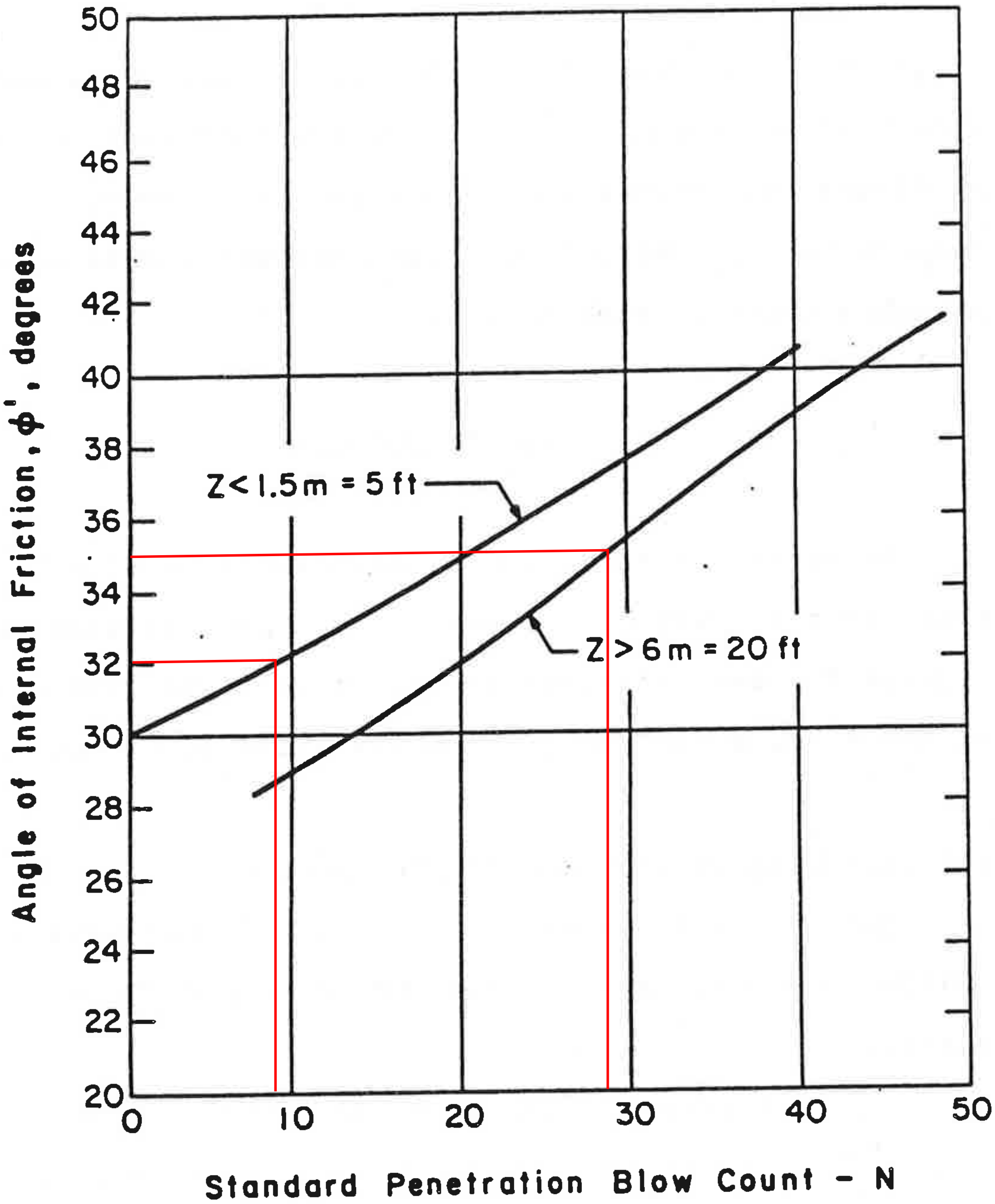
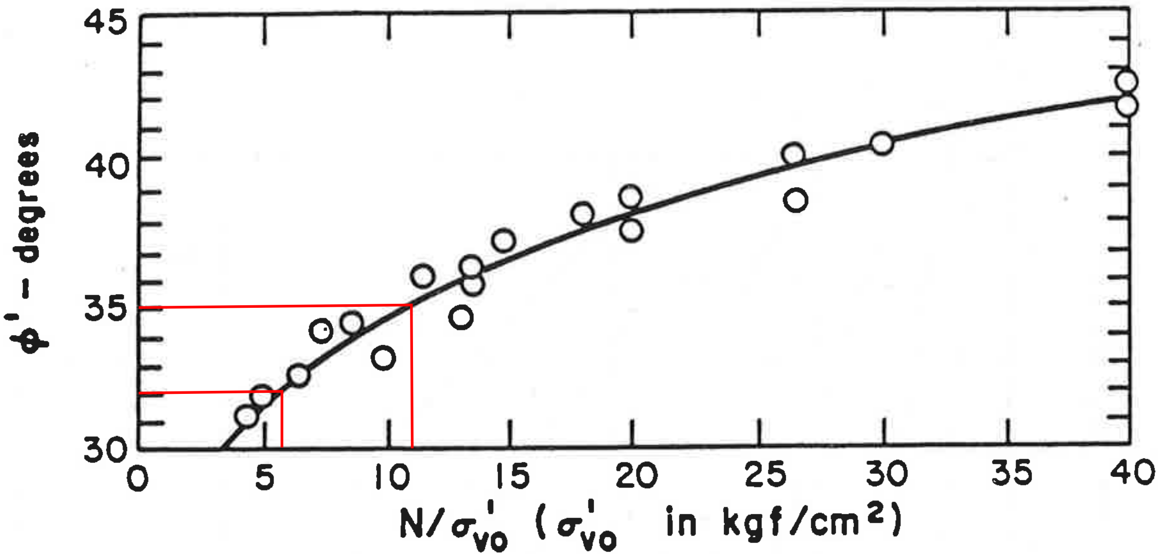


Fig.13 Relationship between Angle of Internal Friction of Cohesionless Soils and SPT Blow Count, (After Sowers, 1979).

Attachment 3-3

Relation between ϕ' and N/σ'_{vo}



(a) Relation between ϕ' and N/σ'_{vo}, (After Parry, 1977).

Attachment 3-4
NAVFAC DM 7.2 Table 1 Typical Properties of Compacted Soils

ıABLE 1
Typical Properties of Compacted Soils

Group Symbol	Soil Type	Range of Maximum Dry Unit Weight, pcf	Range of Optimum Moisture, Percent	Typical Value of Compression		Typical Strength Characteristics				Typical Coefficient of Permeability ft./min.	Range of CBR Values	Range of Subgrade Modulus k lbs/cu in.
				At 1.4 tsf (20 psi)	At 3.6 tsf (50 psi)	Cohesion (as compacted) psf	Cohesion (saturated) psf	ϕ (Effective Stress Envelope Degrees)	Tan ϕ			
				Percent of Original Height								
GW	Well graded clean gravels, gravel-sand mixtures.	125 - 135	11 - 8	0.3	0.6	0	0	>38	>0.79	5 x 10^{-2}	40 - 80	300 - 500
GP	Poorly graded clean gravels, gravel-sand mix	115 - 125	14 - 11	0.4	0.9	0	0	>37	>0.74	10^{-1}	30 - 60	250 - 400
GM	Silty gravels, poorly graded gravel-sand-silt.	120 - 135	12 - 8	0.5	1.1	.....	.....	>34	>0.67	>10^{-6}	20 - 60	100 - 400
GC	Clayey gravels, poorly graded gravel-sand-clay.	115 - 130	14 - 9	0.7	1.6	.....	.....	>31	>0.60	>10^{-7}	20 - 40	100 - 300
SW	Well graded clean sands, gravelly sands.	110 - 130	16 - 9	0.6	1.2	0	0	38	0.79	>10^{-3}	20 - 40	200 - 300
SP	Poorly graded clean sands, sand-gravel mix.	100 - 120	21 - 12	0.8	1.4	0	0	37	0.74	>10^{-3}	10 - 40	200 - 300
SM	Silty sands, poorly graded sand-silt mix.	110 - 125	16 - 11	0.8	1.6	1050	420	34	0.67	5 x >10^{-5}	10 - 40	100 - 300
SM-SC	Sand-silt clay mix with slightly plastic fines.	110 - 130	15 - 11	0.8	1.4	1050	300	33	0.66	2 x >10^{-6}	5 - 30	100 - 300
SC	Clayey sands, poorly graded sand-clay-mix.	105 - 125	19 - 11	1.1	2.2	1550	230	31	0.60	5 x >10^{-7}	5 - 20	100 - 300
ML	Inorganic silts and clayey silts.	95 - 120	24 - 12	0.9	1.7	1400	190	32	0.62	>10^{-5}	15 or less	100 - 200
ML-CL	Mixture of inorganic silt and clay.	100 - 120	22 - 12	1.0	2.2	1350	460	32	0.62	5 x >10^{-7}	.....	
CL	Inorganic clays of low to medium plasticity.	95 - 120	24 - 12	1.3	2.5	1800	270	28	0.54	>10^{-7}	15 or less	50 - 200
OL	Organic silts and silt-clays, low plasticity.	80 - 100	33 - 21	.....	.....	.....	.....	.....	.....	.....	5 or less	50 - 100
MH	Inorganic clayey silts, elastic silts.	70 - 95	40 - 24	2.0	3.8	1500	420	25	0.47	5 x >10^{-7}	10 or less	50 - 100
CH	Inorganic clays of high plasticity	75 - 105	36 - 19	2.6	3.9	2150	230	19	0.35	>10^{-7}	15 or less	50 - 150
OH	Organic clays and silty clays	65 - 100	45 - 21	.....	.....	.....	.....	.....	.....	.....	5 or less	25 - 100

Notes:

1. All properties are for condition of "Standard Proctor" maximum density, except values of k and CBR which are for "modified Proctor" maximum density.
2. Typical stength characteristics are for effective strength envelopes and are obtained from USBR data.
3. Compression values are for vertical loading with complete lateral confinement.
4. (>) indicates that typical property is greater than the value shown.
(..) indicates insufficient data available for an estimate.

Appendix G

Seismic Analyses

Client	SCVWD	Project	11540-0	Page	1
Subject	Llagas Creek Levee Evaluation	Date	4/20/12	By	MJP/ TMH
	Seismic Stability Assessment	Checked	5/30/12	By	LJS
		Approved	5/30/12	By	MJF

Liquefaction Analysis and Seismic Slope Stability

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Liquefaction Analysis and Seismic Slope Stability Text

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Table G-2 Summary of Seismic Slope Stability Analyses Station 78+00
Table G-3 Summary of Seismic Slope Stability Analyses Station 92+50
Table G-4 Summary of Seismic Slope Stability Analyses Station 106+50

Figures

Figures G-1 to G-4 Sta. 50+00 Seismic Stability Analyses
Figures G-5 to G-8 Sta. 78+00 Seismic Stability Analyses
Figures G-9 to G-12 Sta. 92+50 Seismic Stability Analyses
Figures G-13 to G-16 Sta. 106+50 Seismic Stability Analyses

Purpose:

This document summarizes the seismic stability assessment performed for the Llagas Creek Levees.

Analysis Approach:

Our approach to this analysis includes the following steps:

1. Estimate the peak ground acceleration (PGA) from the USGS website.
2. Evaluate the liquefaction and cyclic strength reduction susceptibility of the foundation soils.
3. Evaluate post-liquefaction reconsolidation and seismically induced settlements
4. Evaluate the slope stability using post-seismic shear strengths of the foundation soils.
5. Based on guidance from USACE Engineering Circular EC 1110-2-6067, determine the post-earthquake slope stability factor of safety using post-seismic shear strengths of soils in the SLOPE/W limit equilibrium stability analysis

   If the post earthquake factors of safety are less than a 1.2, perform a more detailed seismic deformation analysis based on Step 6 below to determine potential slope deformations. If post earthquake factors of safety are greater than 1.2, seismic deformations are anticipated to be negligible and no further evaluation of deformations is necessary.

6. Estimate post-seismic deformations using the Makdisi and Seed modified Newmark approach. This approach includes the following steps

   a) Estimate the maximum acceleration at the levee crest U_{max} based on the PGA.
   b) Estimate the average acceleration for a potential sliding mass k_{max}

c) Determine the yield acceleration (k_y) using limit slope stability equilibrium methods in SLOPE/W. The k_y value is a pseudo-static horizontal acceleration value at which a critical sliding surface would develop a factor of safety of 1.0, and movements could occur along the direction of the sliding surface.

d) The magnitude of displacements is computed empirically by determining the ratio of yield acceleration to the average acceleration of the potential sliding mass (k_y/k_{max})ratio using the chart below.

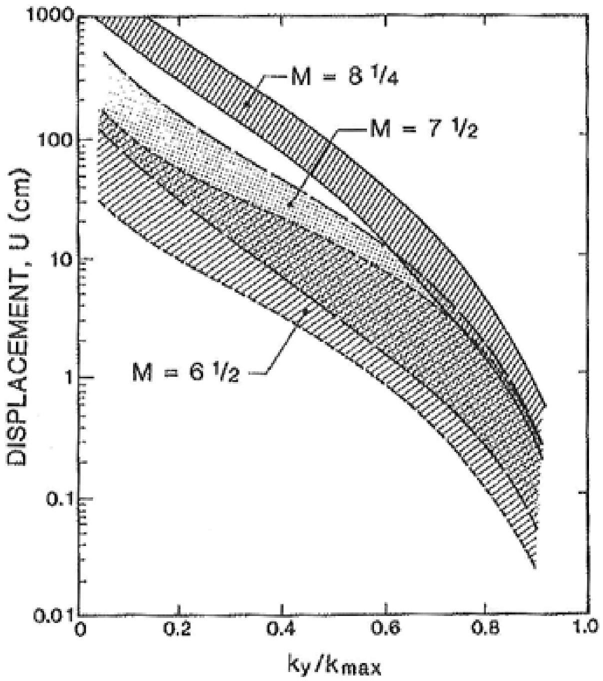


Figure 10.23 Variation of permanent displacement with yield acceleration. (From Makdisi and Seed, 1977.)

Summary:

Using the 1 in 100-year ground motion stipulated in USACE EC 1110-2-6067, Section 9h(6), the peak ground acceleration for the 1-in-100 return period for this site is estimated to be 0.45 g.

Layers were identified within the foundation soils that are susceptible to liquefaction and cyclic strength reduction. The estimated post-seismic shear strengths for analysis are summarized in the attached tables.

The post-seismic stability analyses resulted in an estimated factor of safety greater than 1.2 for both landside and waterside slopes of the analysis cross-sections developed at 50+00, 78+00, 92+50, and 106+50. Slope displacements are anticipated to be negligible, and based on USACE EC 1110-2-6067, further evaluation of slope deformations is not required.

Using Idriss and Boulanger (2008), we estimate post-liquefaction reconsolidation settlements of up to 4 inches along the levee alignments.

Seismically-induced settlement of the near-surface soils is not anticipated at the site.

Step 1 – Estimate the Peak Horizontal Ground Accelerations:

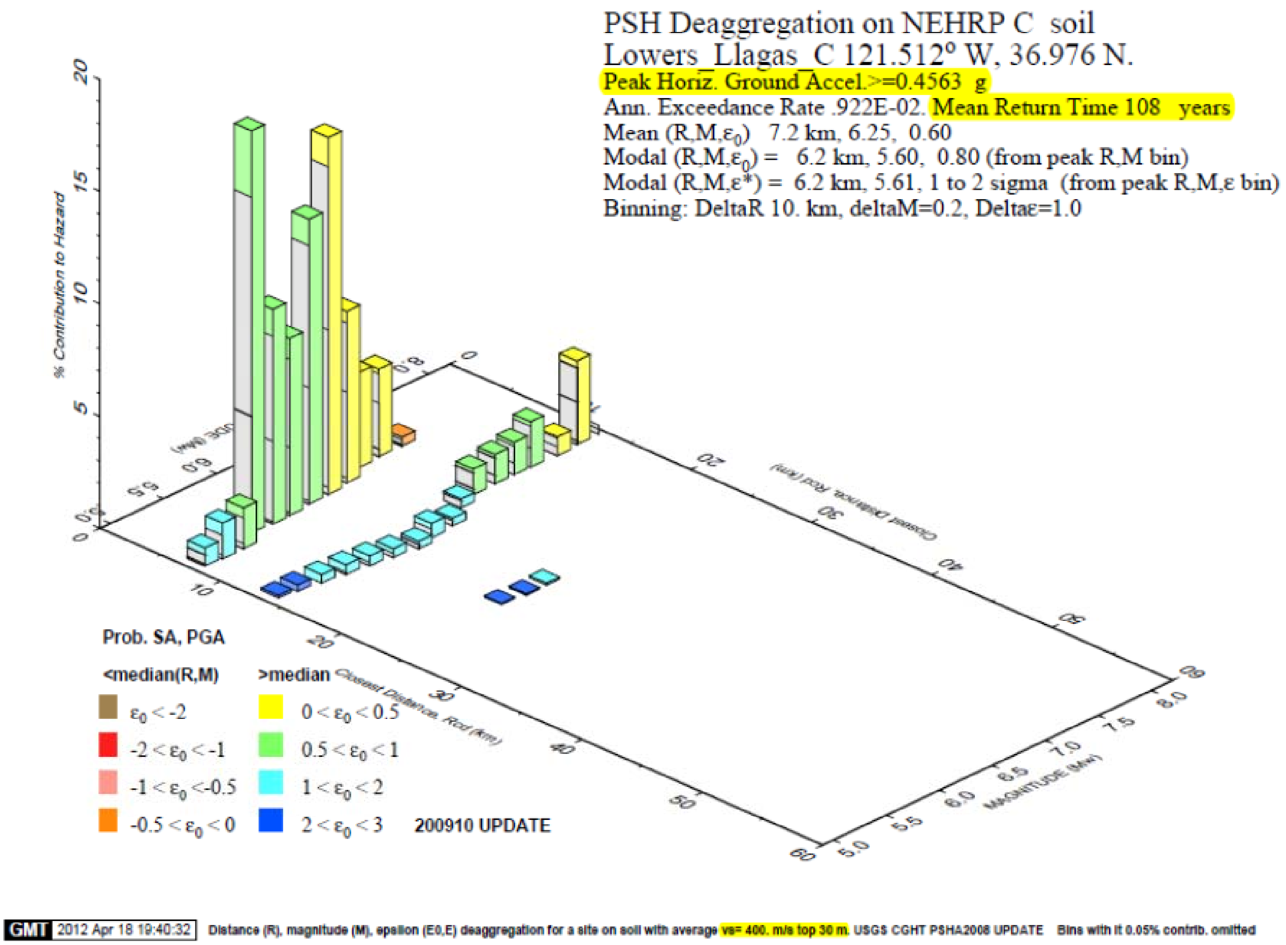
We used the USGS 2008 deaggregation website (https://geohazards.usgs.gov/deaggint/2008/) to estimate peak horizontal ground accelerations (PGA). With the 2008 updated source and attenuation models, we are able to estimate PGA's at the ground surface based on estimated shear wave velocities of the upper 100 feet (30 meters) of the soils at the site.

For the site conditions at the Llagas Creek levees (predominantly soft to stiff clays, medium dense silty sands and dense sands) we assumed a Site D soil classification, with shear wave velocities between 180 and 400 m/sec. This range of shear wave values was used to perform a sensitivity analysis, to determine how the average shear wave velocities could affect the site PGA. The soil classification is based on the National Earthquake Hazard Reduction Program (NEHERP) guidelines.

The PGA varies less than 0.1g within the Site D classification range (180 to 400 m/sec) for a given return period. Based on the interactive deaggregations performed for 50% in 75-year (1-in 108) ground motions, it appears that the highest PGA values are obtained at a 400 m/sec average shear wave velocity.

The Calaveras Fault is the dominant seismic source, as indicated by the large spike in the binned bar plots close to the median magnitude and distance for the probabilistic ground motions. (M= 6.5, Distance = 5km (see Figure 1). The 5km value represents the closest distance of the levee alignment to the Calaveras Fault.

Figure 1 – Site PGA for Vs30 = 400 m/sec; 50% in 75-year (1-in-108)



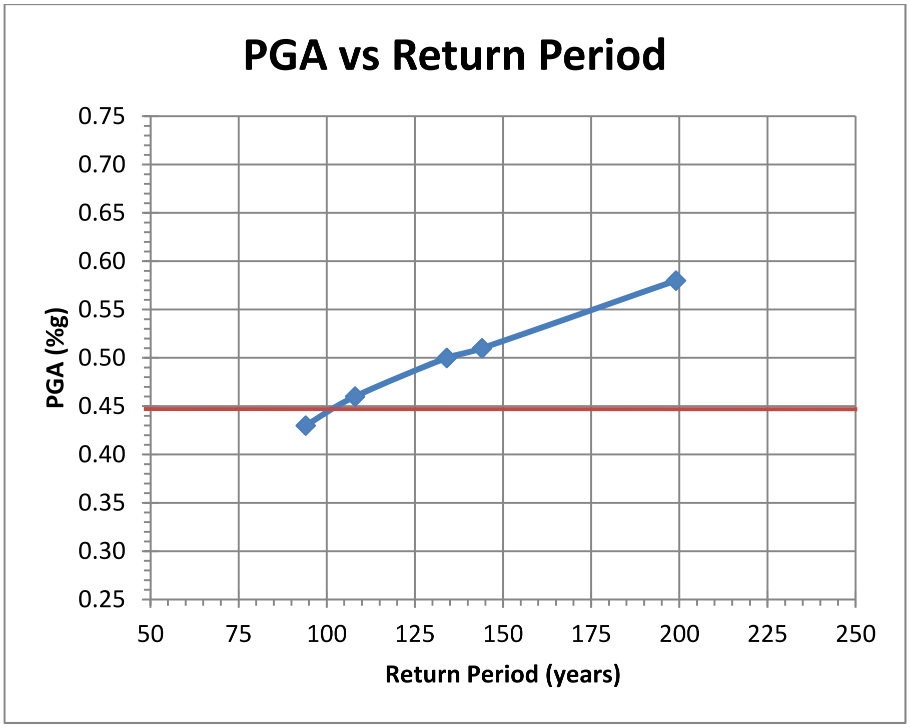
PSH Deaggregation on NEHRP C soil
Lowers_Llagas_C 121.512° W, 36.976 N.
Peak Horiz. Ground Accel.>=0.4563 g
Ann. Exceedance Rate .922E-02. Mean Return Time 108 years
Mean (R,M,ε_0) 7.2 km, 6.25, 0.60
Modal (R,M,ε_0) = 6.2 km, 5.60, 0.80 (from peak R,M bin)
Modal (R,M,ε^*) = 6.2 km, 5.61, 1 to 2 sigma (from peak R,M,ε bin)
Binning: DeltaR 10. km, deltaM=0.2, Deltaε=1.0

Distance (R), magnitude (M), epsilon (E0,E) deaggregation for a site on soil with average vs= 400. m/s top 30 m. USGS CGHT PSHA2008 UPDATE Bins with lt 0.05% contrib. omitted

GEI Consultants

Client	SCVWD	Project	11540-0	Page	5
Subject	Llagas Creek Levee Evaluation	Date	4/20/12	By	MJP/ TMH
	Seismic Stability Assessment	Checked	5/30/12	By	LJS
		Approved	5/30/12	By	MJF

We plotted a graph of PGA versus return period which includes the points for several return periods (including the 1-in-108 year ground motions), assuming a soil profile with an average Vs = 400 m/sec.



From our plot, we estimated the PGA for the 100-year return period event is **0.45 g**.

Step 2 – Evaluate Liquefaction and Cyclic Strength Reduction of Foundation Soils

We evaluated the post-seismic shear strengths of the foundation soils for the 100-year return period seismic event for the analysis cross-sections developed at 50+00, 78+00, 92+50, and 106+50, where layers were identified within the foundation soils that are susceptible to either liquefaction or cyclic strength reduction. Visual classification and laboratory test results from the borings were used for site-specific correlation of CPT data.

The estimated post-seismic shear strengths (S_r) for the susceptible layers within these analysis sections are summarized in the **Tables G-1 through G-4**.

Coarse-Grained Soils

For coarse–grained soils we corrected CPT penetration tip resistance from the data collected by CPT, Inc. during the subsurface exploration. For each coarse grained soil layer encountered, The CPT penetration tip resistance values were corrected to an equivalent clean sand value, $q_{c1N60-cs}$, as described in Idriss and Boulanger (2008) and empirical relationships by Seed and Harder (1990).

For each soil layer we estimated a Cyclic Stress Ratio (CSR) and Cyclic Resistance Ratio (CRR). A factor of safety against liquefaction was determined by dividing CRR by CSR. Layers where the factor of safety against liquefaction was less than 1.0 were considered susceptible to liquefaction.

Once it was determined a soil layer was liquefiable, we took the average $q_{c1N60-cs}$ throughout the layer and obtained approximate residual undrained shear strengths (S_r), based on Equation 82 and Fig. 90 from Idriss and Boulanger (2008).

Fine-Grained Soils

We evaluated the fine-grained soils under the embankment for susceptibility to strength reduction due to cyclic loading. We used the procedure detailed in Idriss and Boulanger (2008). Layers where the factor of safety was less than 1.0 were considered susceptible to strength reduction due to cyclic loading. Susceptible layers were assigned residual undrained shear strengths (S_r), based on the procedures outlined in URS (2007).

Step 3- Evaluate Post-Liquefaction Reconsolidation and Seismically Induced Settlement

Using the procedures described in Idriss and Boulanger (2008), we estimated post-liquefaction reconsolidation settlements along the Line A levee alignment. Reconsolidation settlements were estimated along the length of the levee reach using the data from the CPTs of sufficient depth performed at the levee crown and toe. Visual classification and laboratory test results from the borings were used for site-specific correlation of CPT data. Based on the results of these analyses, we estimate post-liquefaction reconsolidation settlements of up to 4 inches along the levee alignment.

Strong ground shaking can also cause settlement of unsaturated soils above the groundwater table. Soils considered susceptible to seismically-induced settlement are generally loose, cohesionless soils and poorly compacted fills. The surficial soils encountered in our borings and CPTs above the groundwater table were cohesive and relatively stiff; therefore, seismically-induced settlement of the near-surface soils is not anticipated at the site.

Steps 4 and 5 – Evaluate Post-Seismic Slope Stability and Compare to USACE 1110-2-6067 Criteria

Using SLOPE/W, we evaluated post-seismic slope stability for both the landside and waterside levee slopes for the analysis cross-sections developed at 50+00, 78+00, 92+50, and 106+50. These analyses used the post-liquefaction shear strengths and no seismic coefficient. Stability was evaluated using the Morgenstern and Price analysis method, which satisfies both moment and force equilibrium. Slip surfaces were defined using the grid and radius method.

The factors of safety for both the landside and waterside cases were greater than 1.2 indicating the levee is likely to be stable with post-seismic shear strengths. Based on the USACE 1110-2-6067 criteria, seismic deformation analyses indicated in Step 6 were not performed. Graphical output results of the SLOPE/W static stability analyses are provided in the **Figures G-1 through G-16**.

References:

URS Corporation (2007), "Guidance Document for Geotechnical Analyses, DWR Urban Levee Geotechnical Evaluations Program", Report to DWR, Division of Flood Management, dated July 2, 2007.

Seed, R.B., et. Al. (2003), "Recent Advances in Soil Liquefaction Engineering: A Unified and Consistent Framework", 26th Annual ASCE Los Angeles Technical Spring Seminar, Keynote Presentation, Long Beach, CA, pp. 1-71.

Seed, R.B., Harder, L.F.H., Jr. (1990), "SPT-based Analysis of Cyclic Pore Pressure Generation and Undrained Residual Shear Strength", in Proceedings of "H.B. Seed Memorial Symposium, Vol. II, May, pp. 351-376.

Boulanger, R.W., and Idriss, I.M. (2004), "Evaluating the Potential for Liquefaction or Cyclic Failure of Silts and Clays", Report No. UCD/CGM-04/01, University of California at Davis.

Sharma, H.D. and Lewis, S.P. (1994), "Waste Containment Systems, Waste Stabilization and Landfills Design and Evaluation."

Bray, J.D. et al. (1998), "Simplified Seismic Design Procedure for Geosynthetic Lined, Solid Waste Landfills", Geosynthetics International 1998, Vol. 5, Nos. 1 and 2.

Karavanjian, E. Jr., Matasovic, N., Hadj-Hamou, T., Sabatini, P.J. (1997) Design Guidance: Geotechnical Earthquake Engineering for Highways, Vol. 1: Design Principals, Geotechnical Engineering Circular 3, FHWA-SA-97-076, Federal Highways Administration, U.S. Department of Transportation, Washington, D.C.

USACE Process for the National Flood Insurance Program (NFIP) Levee System Evaluation, Engineering Circular EC-1110-2-6067, US Army Corps of Engineers, Washington D.C., August 31, 2010

TABLE G-1
SUMMARY OF SLOPE STABILITY ANALYSES - STA 50+00 (REACH 1)

Section	**Case**	**Analyzed Slope**	**Water Surface**	Model Parameters					Min. Required Factor of Safety	**Calculated Factor of Safety**	Notes
				Layers	Strength Parameters c'	Strength Parameters phi'	Strength Parameters su	Unit Weight (pcf)			
Station 50+00 West	Seismic	Landside	Water level in channel under normal winter conditions, El. 142	**Levee Fill**	-	-	1150	115	1.2	3.28	1) Use Drained Strengths for non-liquefiable granular soils, 2) use residual undrained strengths for liquefiable soils, 3) use 0.8*Su for cohesive soils, assuming soils are sensitive to cyclic strength reduction
		3.3H:1V slope		**Loose Levee Fill**	-	-	675	110			
				Softer Fine Grained Alluvium- CH (Fat Clays)	-	-	600	110			
				Peat- PT	-	-	400	70			
				Peat Under Levee- PT	-	-	400	70			
				Softer Fine Grained Alluvium- CH (Fat Clays)	-	-	600	110			
				Stiffer Fine Grained Alluvium- Lean to Fat Clays (CL/CH)	-	-	1200	120			
		(Input Pseudostatic Coefficient to produce FS= 1.0)		**Liquefied Clean Coarse Grained Alluvium**- Dense Poorly Graded Sands/ Gravel with Sands (GP/SP)	-	-	450	140			
				Clean Coarse Grained Alluvium- Dense Poorly Graded Sands/ Gravel with Sands (GP/SP)	0	35	-	140			
				Stiffer Fine Grained Alluvium - Lean Clays (CL)	-	-	1200	120			
Station 50+00 West	Seismic	Waterside	Water level in channel under normal winter conditions, El. 142	**Levee Fill**	-	-	1150	115	1.2	2.33	1) Use Drained Strengths for non-liquefiable granular soils, 2) use residual undrained strengths for liquefiable soils, 3) use 0.8*Su for cohesive soils, assuming soils are sensitive to cyclic strength reduction
		2.5H:1V slope		**Loose Levee Fill**	-	-	675	110			
				Softer Fine Grained Alluvium- CH (Fat Clays)	-	-	600	110			
				Peat- PT	-	-	400	70			
				Peat Under Levee- PT	-	-	400	70			
				Softer Fine Grained Alluvium- CH (Fat Clays)	-	-	600	110			
				Stiffer Fine Grained Alluvium- Lean to Fat Clays (CL/CH)	-	-	1200	120			
		(Input Pseudostatic Coefficient to produce FS= 1.0)		**Liquefied Clean Coarse Grained Alluvium**- Dense Poorly Graded Sands/ Gravel with Sands (GP/SP)	-	-	450	140			
				Clean Coarse Grained Alluvium- Dense Poorly Graded Sands/ Gravel with Sands (GP/SP)	0	35	-	140			
				Stiffer Fine Grained Alluvium - Lean Clays (CL)	-	-	1200	120			
Station 50+00 East	Seismic	Landside	Water level in channel under normal winter conditions, El. 142	**Levee Fill**	-	-	1150	115	1.2	2.75	1) Use Drained Strengths for non-liquefiable granular soils, 2) use residual undrained strengths for liquefiable soils, 3) use 0.8*Su for cohesive soils, assuming soils are sensitive to cyclic strength reduction
		2.2H:1V slope		**Loose Levee Fill**	-	-	675	110			
				Softer Fine Grained Alluvium- CH (Fat Clays)	-	-	600	110			
				Peat- PT	-	-	400	70			
				Peat Under Levee- PT	-	-	400	70			
				Softer Fine Grained Alluvium- CH (Fat Clays)	-	-	600	110			
				Stiffer Fine Grained Alluvium- Lean to Fat Clays (CL/CH)	-	-	1200	120			
		(Input Pseudostatic Coefficient to produce FS= 1.0)		**Liquefied Clean Coarse Grained Alluvium**- Dense Poorly Graded Sands/ Gravel with Sands (GP/SP)	-	-	450	140			
				Clean Coarse Grained Alluvium- Dense Poorly Graded Sands/ Gravel with Sands (GP/SP)	0	35	-	140			
				Stiffer Fine Grained Alluvium - Lean Clays (CL)	-	-	1200	120			
Station 50+00 East	Seismic	Waterside	Water level in channel under normal winter conditions, El. 142	**Levee Fill**	-	-	1150	115	1.2	2.27	1) Use Drained Strengths for non-liquefiable granular soils, 2) use residual undrained strengths for liquefiable soils, 3) use 0.8*Su for cohesive soils, assuming soils are sensitive to cyclic strength reduction
		2.7H:1V slope		**Loose Levee Fill**	-	-	675	110			
				Softer Fine Grained Alluvium- CH (Fat Clays)	-	-	600	110			
				Peat- PT	-	-	400	70			
				Peat Under Levee- PT	-	-	400	70			
				Softer Fine Grained Alluvium- CH (Fat Clays)	-	-	600	110			
		(Input Pseudostatic Coefficient to produce FS= 1.0)		**Stiffer Fine Grained Alluvium**- Lean to Fat Clays (CL/CH)	-	-	1200	120			
				Liquefied Clean Coarse Grained Alluvium- Dense Poorly Graded Sands/ Gravel with Sands (GP/SP)	-	-	450	140			
				Clean Coarse Grained Alluvium- Dense Poorly Graded Sands/ Gravel with Sands (GP/SP)	0	35	-	140			
				Stiffer Fine Grained Alluvium - Lean Clays (CL)	-	-	1200	120			

TABLE G-2

SUMMARY OF SLOPE STABILITY ANALYSES - STA 78+00 (REACH 2A)

				Model Parameters					Min. Required Factor of Safety	**Calculated Factor of Safety**	
					Strength Parameters			Unit Weight			
Section	**Case**	**Analyzed Slope**	**Water Surface**	Layers	c'	phi'	su	(pcf)			Notes
Station 78+00 West	Seismic	Landside	Water level in channel under normal winter conditions, El. 145	**Levee Fill**	-	-	1190	115	1.2	2.60	1) Use Drained Strengths for non-liquefiable granular soils, 2) use residual undrained strengths for liqufiable soils, 3) use 0.8*Su for cohesive soils, assuming soils are sensitive to cyclic strength reduction
		2.7H:1V slope		**Softer Fine Grained Alluvium Outside Levee**- CH (Fat Clays)	-	-	560	110			
				Stiffer Fine Grained Alluvium Under Levee - CL	-	-	1025	120			
				Peat- PT	-	-	565	70			
				Peat Under Levee- PT	-	-	565	70			
				Stiffer Fine Grained Alluvium- CH (Fat Clays)	-	-	1025	120			
				Coarse Grained Alluvium (>12 percent fines) - Loose to Medium Dense Silty Sand Layer Interbedded with Stiff Lean Clays (SM / CL)	0	32	-	120			
				Coarse Grained Alluvium (5 to 12 percent fines) -Medium Dense to Dense Poorly Graded/ Silty Sands (SP/SM)	0	35	-	140			
		(Input Pseudostatic Coefficient to produce FS= 1.0)		**Liquefied Coarse Grained Alluvium (5 to 12 percent fines) -**Medium Dense to Dense Poorly Graded/ Silty Sands (SP/SM)	-	-	400	140			
				Coarse Grained Alluvium (5 to 12 percent fines) -Medium Dense to Dense Poorly Graded/ Silty Sands (SP/SM)	0	35	-	140			
				Stiffer Fine Grained Alluvium - Stiff Lean Clays (CL)	-	-	1025	120			
Station 78+00 West	Seismic	Waterside	Water level in channel under normal winter conditions, El. 145	**Levee Fill**	-	-	1190	115	1.2	2.19	1) Use Drained Strengths for non-liquefiable granular soils, 2) use residual undrained strengths for liqufiable soils, 3) use 0.8*Su for cohesive soils, assuming soils are sensitive to cyclic strength reduction
		2.3H:1V slope		**Softer Fine Grained Alluvium Outside Levee**- CH (Fat Clays)	-	-	560	110			
				Stiffer Fine Grained Alluvium Under Levee - CL	-	-	1025	120			
				Peat- PT	-	-	565	70			
				Peat Under Levee- PT	-	-	565	70			
				Stiffer Fine Grained Alluvium- CH (Fat Clays)	-	-	1025	120			
				Coarse Grained Alluvium (>12 percent fines) - Loose to Medium Dense Silty Sand Layer Interbedded with Stiff Lean Clays (SM / CL)	0	32	-	120			
				Coarse Grained Alluvium (5 to 12 percent fines) -Medium Dense to Dense Poorly Graded/ Silty Sands (SP/SM)	0	35	-	140			
		(Input Pseudostatic Coefficient to produce FS= 1.0)		**Liquefied Coarse Grained Alluvium (5 to 12 percent fines) -**Medium Dense to Dense Poorly Graded/ Silty Sands (SP/SM)	-	-	400	140			
				Coarse Grained Alluvium (5 to 12 percent fines) -Medium Dense to Dense Poorly Graded/ Silty Sands (SP/SM)	0	35	-	140			
				Stiffer Fine Grained Alluvium - Stiff Lean Clays (CL)	-	-	1025	120			
Station 78+00 East	Seismic	Landside	Water level in channel under normal winter conditions, El. 145	**Levee Fill**	-	-	1190	115	1.2	2.62	1) Use Drained Strengths for non-liquefiable granular soils, 2) use residual undrained strengths for liqufiable soils, 3) use 0.8*Su for cohesive soils, assuming soils are sensitive to cyclic strength reduction
		2.2H:1V slope		**Softer Fine Grained Alluvium Outside Levee**- CH (Fat Clays)	-	-	560	110			
				Stiffer Fine Grained Alluvium Under Levee - CL	-	-	1025	120			
				Peat- PT	-	-	565	70			
				Peat Under Levee- PT	-	-	565	70			
				Stiffer Fine Grained Alluvium- CH (Fat Clays)	-	-	1025	120			
				Coarse Grained Alluvium (>12 percent fines) - Loose to Medium Dense Silty Sand Layer Interbedded with Stiff Lean Clays (SM / CL)	0	32	-	120			
				Coarse Grained Alluvium (5 to 12 percent fines) -Medium Dense to Dense Poorly Graded/ Silty Sands (SP/SM)	0	35	-	140			
		(Input Pseudostatic Coefficient to produce FS= 1.0)		**Liquefied Coarse Grained Alluvium (5 to 12 percent fines) -**Medium Dense to Dense Poorly Graded/ Silty Sands (SP/SM)	-	-	400	140			
				Coarse Grained Alluvium (5 to 12 percent fines) -Medium Dense to Dense Poorly Graded/ Silty Sands (SP/SM)	0	35	-	140			
				Stiffer Fine Grained Alluvium - Stiff Lean Clays (CL)	-	-	1025	120			
Station 78+00 East	Seismic	Waterside	Water level in channel under normal winter conditions, El. 145	**Levee Fill**	-	-	1190	115	1.2	2.14	1) Use Drained Strengths for non-liquefiable granular soils, 2) use residual undrained strengths for liqufiable soils, 3) use 0.8*Su for cohesive soils, assuming soils are sensitive to cyclic strength reduction
		2.3H:1V slope		**Softer Fine Grained Alluvium Outside Levee**- CH (Fat Clays)	-	-	560	110			
				Stiffer Fine Grained Alluvium Under Levee - CL	-	-	1025	120			
				Peat- PT	-	-	565	70			
				Peat Under Levee- PT	-	-	565	70			
				Stiffer Fine Grained Alluvium- CH (Fat Clays)	-	-	1025	120			
				Coarse Grained Alluvium (>12 percent fines) - Loose to Medium Dense Silty Sand Layer Interbedded with Stiff Lean Clays (SM / CL)	0	32	-	120			
				Coarse Grained Alluvium (5 to 12 percent fines) -Medium Dense to Dense Poorly Graded/ Silty Sands (SP/SM)	0	35	-	140			
		(Input Pseudostatic Coefficient to produce FS= 1.0)		**Liquefied Coarse Grained Alluvium (5 to 12 percent fines) -**Medium Dense to Dense Poorly Graded/ Silty Sands (SP/SM)	-	-	400	140			
				Coarse Grained Alluvium (5 to 12 percent fines) -Medium Dense to Dense Poorly Graded/ Silty Sands (SP/SM)	0	35	-	140			
				Stiffer Fine Grained Alluvium - Stiff Lean Clays (CL)	-	-	1025	120			

TABLE G-3
SUMMARY OF SLOPE STABILITY ANALYSES - STA 92+50 (REACH 2A)

Section	Case	Analyzed Slope	Water Surface	Model Parameters Layers	Strength Parameters c'	phi'	su	Unit Weight (pcf)	Min. Required Factor of Safety	Calculated Factor of Safety	Notes
Station 92+50 West	Seismic	Landside	Water level in channel under normal winter condtions, El. 147	**Levee Fill**	-	-	1150	115	1.2	2.66	1) Use Drained Strengths for non-liquefiable granular soils, 2) use residual undrained strengths for liqufiable soils, 3) use 0.8*Su for cohesive soils, assuming soils are sensitive to cyclic strength reduction
		3.2H:1V slope		**Softer Fine Grained Alluvium** -CH (Fat Clays)	-	-	650	110			
				Stiffer Fine Grained Alluvium Under Levee -Stiff Lean Clays and Silts (CL/ ML)	-	-	1020	120			
		(Input Pseudostatic Coefficient to produce FS=		**Liquefied Coarse Grained Alluvium (5 to 12 percent fines)** -Medium Dense to Dense Poorly Graded/Silty Sands (SP/SM)	-	-	500	140			
		1.0)		**Coarse Grained Alluvium (5 to 12 percent fines)** -Medium Dense to Dense Poorly Graded/ Silty Sands (SP/SM)	0	35	-	140			
				Stiffer Fine Grained Alluvium -Stiff Lean Clays and Silts (CL/ ML)	-	-	1020	120			
Station 92+50 West	Seismic	Waterside	Water level in channel under normal winter condtions, El. 147	**Levee Fill**	-	-	1150	115	1.2	2.29	1) Use Drained Strengths for non-liquefiable granular soils, 2) use residual undrained strengths for liqufiable soils, 3) use 0.8*Su for cohesive soils, assuming soils are sensitive to cyclic strength reduction
		2.8H:1V slope		**Softer Fine Grained Alluvium** -CH (Fat Clays)	-	-	650	110			
				Stiffer Fine Grained Alluvium Under Levee -Stiff Lean Clays and Silts (CL/ ML)	-	-	1020	120			
		(Input Pseudostatic Coefficient to produce FS=		**Liquefied Coarse Grained Alluvium (5 to 12 percent fines)** -Medium Dense to Dense Poorly Graded/Silty Sands (SP/SM)	-	-	500	140			
		1.0)		**Coarse Grained Alluvium (5 to 12 percent fines)** -Medium Dense to Dense Poorly Graded/ Silty Sands (SP/SM)	0	35	-	140			
				Stiffer Fine Grained Alluvium -Stiff Lean Clays and Silts (CL/ ML)	-	-	1020	120			
Station 92+50 East	Seismic	Landside	Water level in channel under normal winter condtions, El. 147	**Levee Fill**	-	-	1150	115	1.2	2.87	1) Use Drained Strengths for non-liquefiable granular soils, 2) use residual undrained strengths for liqufiable soils, 3) use 0.8*Su for cohesive soils, assuming soils are sensitive to cyclic strength reduction
		3.2H:1V slope		**Softer Fine Grained Alluvium** -CH (Fat Clays)	-	-	650	110			
				Stiffer Fine Grained Alluvium Under Levee -Stiff Lean Clays and Silts (CL/ ML)	-	-	1020	120			
				Stiffer Fine Grained Alluvium -Stiff Lean Clays and Silts (CL/ ML)	-	-	1020	120			
		(Input Pseudostatic Coefficient to produce FS=		**Liquefied Coarse Grained Alluvium (5 to 12 percent fines)** -Medium Dense to Dense Poorly Graded/Silty Sands (SP/SM)	-	-	500	140			
		1.0)		**Coarse Grained Alluvium (5 to 12 percent fines)** -Medium Dense to Dense Poorly Graded/ Silty Sands (SP/SM)	0	35	-	140			
				Stiffer Fine Grained Alluvium -Stiff Lean Clays and Silts (CL/ ML)	-	-	1020	120			
Station 92+50 East	Seismic	Waterside	Water level in channel under normal winter condtions, El. 147	**Levee Fill**	-	-	1150	115	1.2	2.22	1) Use Drained Strengths for non-liquefiable granular soils, 2) use residual undrained strengths for liqufiable soils, 3) use 0.8*Su for cohesive soils, assuming soils are sensitive to cyclic strength reduction
		2.6H:1V slope		**Softer Fine Grained Alluvium** -CH (Fat Clays)	-	-	650	110			
				Stiffer Fine Grained Alluvium Under Levee -Stiff Lean Clays and Silts (CL/ ML)	-	-	1020	120			
				Stiffer Fine Grained Alluvium -Stiff Lean Clays and Silts (CL/ ML)	-	-	1020	120			
		(Input Pseudostatic Coefficient to produce FS=		**Liquefied Coarse Grained Alluvium (5 to 12 percent fines)** -Medium Dense to Dense Poorly Graded/Silty Sands (SP/SM)	-	-	500	140			
		1.0)		**Coarse Grained Alluvium (5 to 12 percent fines)** -Medium Dense to Dense Poorly Graded/ Silty Sands (SP/SM)	0	35	-	140			
				Stiffer Fine Grained Alluvium -Stiff Lean Clays and Silts (CL/ ML)	-	-	1020	120			

TABLE G-4
SUMMARY OF SLOPE STABILITY ANALYSES - STA 106+50 (REACH 2A)

Section	Case	Analyzed Slope	Water Surface	Model Parameters					Min. Required Factor of Safety	Calculated Factor of Safety	Notes
				Layers	Strength Parameters			Unit Weight			
					c'	phi'	su	(pcf)			
Station 106+50 West	Seismic	Landside	Water level in channel under normal winter conditions, El. 149	**Levee Fill**	-	-	1100	115	1.2	3.11	1) Use Drained Strengths for non-liquefiable granular soils, 2) use residual undrained strengths for liquefiable soils, 3) use 0.8*Su for cohesive soils, assuming soils are sensitive to cyclic strength reduction
		3.3H:1V slope		**Stiffer Fine Grained Alluvium Under Levee -** Stiff Lean Clays and Silts (CL/ ML)	-	-	1000	120			
				Softer Fine Grained Alluvium Outside Levee	-	-	500	110			
		(Input Pseudostatic		**Coarse Grained Alluvium-** Medium Dense to Dense Silty to Poorly Graded Sands (SM/SP)	0	35	-	140			
		Coefficient to produce FS= 1.0)		**Liquefied Coarse Grained Alluvium-** Medium Dense to Dense Silty to Poorly Graded Sands (SM/SP)	-	-	250	140			
				Stiffer Fine Grained Alluvium- Stiff Lean Clays and Silts (CL/ ML)	-	-	1000	120			
Station 106 + 50 West	Seismic	Waterside	Water level in channel under normal winter conditions, El. 149	**Levee Fill**	-	-	1100	115	1.2	2.13	1) Use Drained Strengths for non-liquefiable granular soils, 2) use residual undrained strengths for liquefiable soils, 3) use 0.8*Su for cohesive soils, assuming soils are sensitive to cyclic strength reduction
		3.2H:1V slope		**Stiffer Fine Grained Alluvium Under Levee -** Stiff Lean Clays and Silts (CL/ ML)	-	-	1000	120			
		(Input Pseudostatic		**Softer Fine Grained Alluvium Outside Levee**	-	-	500	110			
		(Input Pseudostatic		**Coarse Grained Alluvium-** Medium Dense to Dense Silty to Poorly Graded Sands (SM/SP)	0	35	-	140			
		Coefficient to produce FS= 1.0)		**Liquefied Coarse Grained Alluvium-** Medium Dense to Dense Silty to Poorly Graded Sands (SM/SP)	-	-	250	140			
				Stiffer Fine Grained Alluvium- Stiff Lean Clays and Silts (CL/ ML)	-	-	1000	120			
Station 106+50 East	Seismic	Landside	Water level in channel under normal winter conditions, El. 149	**Levee Fill**	-	-	1100	115	1.2	3.37	1) Use Drained Strengths for non-liquefiable granular soils, 2) use residual undrained strengths for liquefiable soils, 3) use 0.8*Su for cohesive soils, assuming soils are sensitive to cyclic strength reduction
		3.3H:1V slope		**Stiffer Fine Grained Alluvium Under Levee -** Stiff Lean Clays and Silts (CL/ ML)	-	-	1000	120			
				Softer Fine Grained Alluvium Outside Levee	-	-	500	110			
		(Input Pseudostatic		**Coarse Grained Alluvium-** Medium Dense to Dense Silty to Poorly Graded Sands (SM/SP)	0	35	-	140			
		Coefficient to produce FS= 1.0)		**Liquefied Coarse Grained Alluvium-** Medium Dense to Dense Silty to Poorly Graded Sands (SM/SP)	-	-	250	140			
				Stiffer Fine Grained Alluvium- Stiff Lean Clays and Silts (CL/ ML)	-	-	1000	120			
Station 106+50 East	Seismic	Waterside	Water level in channel under normal winter conditions, El. 149	**Levee Fill**	-	-	1100	115	1.2	1.77	1) Use Drained Strengths for non-liquefiable granular soils, 2) use residual undrained strengths for liquefiable soils, 3) use 0.8*Su for cohesive soils, assuming soils are sensitive to cyclic strength reduction
		2.1H:1V slope		**Stiffer Fine Grained Alluvium Under Levee -** Stiff Lean Clays and Silts (CL/ ML)	-	-	1000	120			
				Softer Fine Grained Alluvium Outside Levee	-	-	500	110			
		(Input Pseudostatic		**Coarse Grained Alluvium-** Medium Dense to Dense Silty to Poorly Graded Sands (SM/SP)	0	35	-	140			
		Coefficient to produce FS= 1.0)		**Liquefied Coarse Grained Alluvium-** Medium Dense to Dense Silty to Poorly Graded Sands (SM/SP)	-	-	250	140			
				Stiffer Fine Grained Alluvium- Stiff Lean Clays and Silts (CL/ ML)	-	-	1000	120			

Lower Llagas Creek Capacity Restoration Capital Project

Station 50+00 Landside Seismic Stability Analysis - West Levee

Model stratigraphy and characteristics developed using geologic information
from CPT-049+00E, B-050+00W, and CPT-050+00W
Topography based on 2007 LiDAR data provided by SCVWD for Project use
Design Water Surface Elevation (Design WSE) provided by SCVWD
All elevations reference North American Vertical Datum of 1988 (NAVD88)

Analysis Section Details
Winter WSE - 142.0'

West Levee

Crest Elevation	154.1'
Crest Width	23.3'
Waterside Slope	2.5H:1V
Waterside Toe Elevation	139.0'
Landside Slope	3.3H:1V
Landside Toe Elevation	144.0'
Factor of Safety	3.28

Levee Fill
Unit Weight: 115 pcf
Cohesion: 1150 psf

Peat
Unit Weight: 70 pcf
Cohesion: 400 psf

Liquefied Coarse Grained Alluvium < 5% Fines
Unit Weight: 140 pcf
Cohesion: 450 psf

Softer Fine Grained Alluvium
Unit Weight: 110 pcf
Cohesion: 600 psf

Stiffer Alluvium Fine Grained
Unit Weight: 120 pcf
Cohesion: 1200 psf

Coarse Grained Alluvium < 5% Fines
Unit Weight: 140 pcf
Cohesion: 0 psf
Phi: 35 °

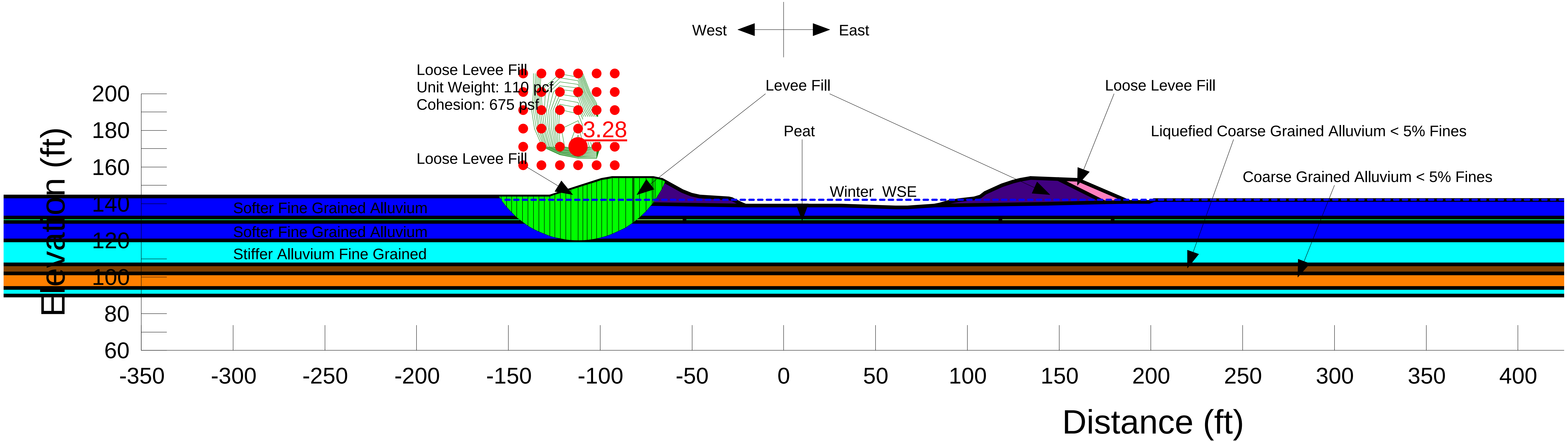


FIGURE G-1

Lower Llagas Creek Capacity Restoration Capital Project

Station 50+00 Waterside Seismic Stability Analysis - West Levee

Model stratigraphy and characteristics developed using geologic information
from CPT-049+00E, B-050+00W, and CPT-050+00W
Topography based on 2007 LiDAR data provided by SCVWD for Project use
Design Water Surface Elevation (Design WSE) provided by SCVWD
All elevations reference North American Vertical Datum of 1988 (NAVD88)

Analysis Section Details
Winter WSE - 142.0'

West Levee

Levee Fill
Unit Weight: 115 pcf
Cohesion: 1150 psf

Peat
Unit Weight: 70 pcf
Cohesion: 400 psf

Liquefied Coarse Grained Alluvium < 5% Fines
Unit Weight: 140 pcf
Cohesion: 450 psf

Crest Elevation	154.1'
Crest Width	23.3'
Waterside Slope	2.5H:1V
Waterside Toe Elevation	139.0'
Landside Slope	3.3H:1V
Landside Toe Elevation	144.0'
Factor of Safety	2.33

Softer Fine Grained Alluvium
Unit Weight: 110 pcf
Cohesion: 600 psf

Stiffer Alluvium Fine Grained
Unit Weight: 120 pcf
Cohesion: 1200 psf

Coarse Grained Alluvium < 5% Fines
Unit Weight: 140 pcf
Cohesion: 0 psf
Phi: 35 °

Loose Levee Fill
Unit Weight: 110 pcf
Cohesion: 675 psf

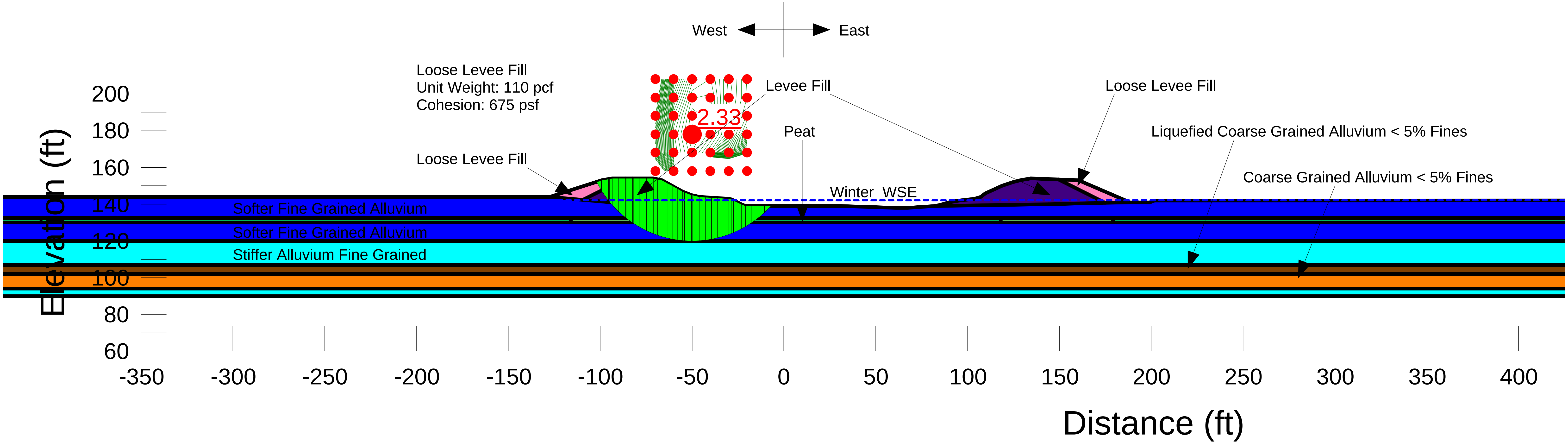


FIGURE G-2

Lower Llagas Creek Capacity Restoration Capital Project

Station 50+00 Landside Seismic Stability Analysis - East Levee

Model stratigraphy and characteristics developed using geologic information
from CPT-049+00E, B-050+00W, and CPT-050+00W
Topography based on 2007 LiDAR data provided by SCVWD for Project use
Design Water Surface Elevation (Design WSE) provided by SCVWD
All elevations reference North American Vertical Datum of 1988 (NAVD88)

Analysis Section Details
Winter WSE - 142.0'

East Levee

Levee Fill
Unit Weight: 115 pcf
Cohesion: 1150 psf

Peat
Unit Weight: 70 pcf
Cohesion: 400 psf

Liquefied Coarse Grained Alluvium < 5% Fines
Unit Weight: 140 pcf
Cohesion: 450 psf

Crest Elevation	154.0'
Crest Width	26.0'
Waterside Slope	2.7H:1V
Waterside Toe Elevation	138.0'
Landside Slope	2.2H:1V
Landside Toe Elevation	141.0'
Factor of Safety	2.75

Softer Fine Grained Alluvium
Unit Weight: 110 pcf
Cohesion: 600 psf

Stiffer Alluvium Fine Grained
Unit Weight: 120 pcf
Cohesion: 1200 psf

Coarse Grained Alluvium < 5% Fines
Unit Weight: 140 pcf
Cohesion: 0 psf
Phi: 35 °

Loose Levee Fill
Unit Weight: 110 pcf
Cohesion: 675 psf

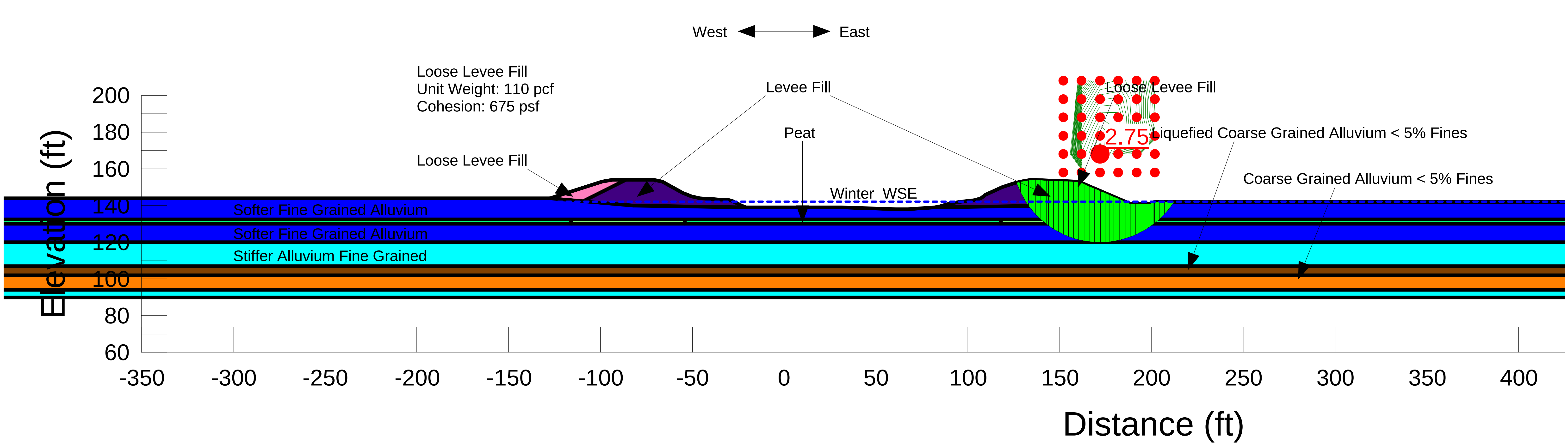


FIGURE G-3

Lower Llagas Creek Capacity Restoration Capital Project

Station 50+00 Waterside Seismic Stability Analysis - East Levee

Model stratigraphy and characteristics developed using geologic information
from CPT-049+00E, B-050+00W, and CPT-050+00W
Topography based on 2007 LiDAR data provided by SCVWD for Project use
Design Water Surface Elevation (Design WSE) provided by SCVWD
All elevations reference North American Vertical Datum of 1988 (NAVD88)

Analysis Section Details

Winter WSE - 142.0'

East Levee

Crest Elevation	154.0'
Crest Width	26.0'
Waterside Slope	2.7H:1V
Waterside Toe Elevation	138.0'
Landside Slope	2.2H:1V
Landside Toe Elevation	141.0'
Factor of Safety	2.27

Levee Fill
Unit Weight: 115 pcf
Cohesion: 1150 psf

Peat
Unit Weight: 70 pcf
Cohesion: 400 psf

Liquefied Coarse Grained Alluvium < 5% Fines
Unit Weight: 140 pcf
Cohesion: 450 psf

Softer Fine Grained Alluvium
Unit Weight: 110 pcf
Cohesion: 600 psf

Stiffer Alluvium Fine Grained
Unit Weight: 120 pcf
Cohesion: 1200 psf

Coarse Grained Alluvium < 5% Fines
Unit Weight: 140 pcf
Cohesion: 0 psf
Phi: 35 °

Loose Levee Fill
Unit Weight: 110 pcf
Cohesion: 675 psf

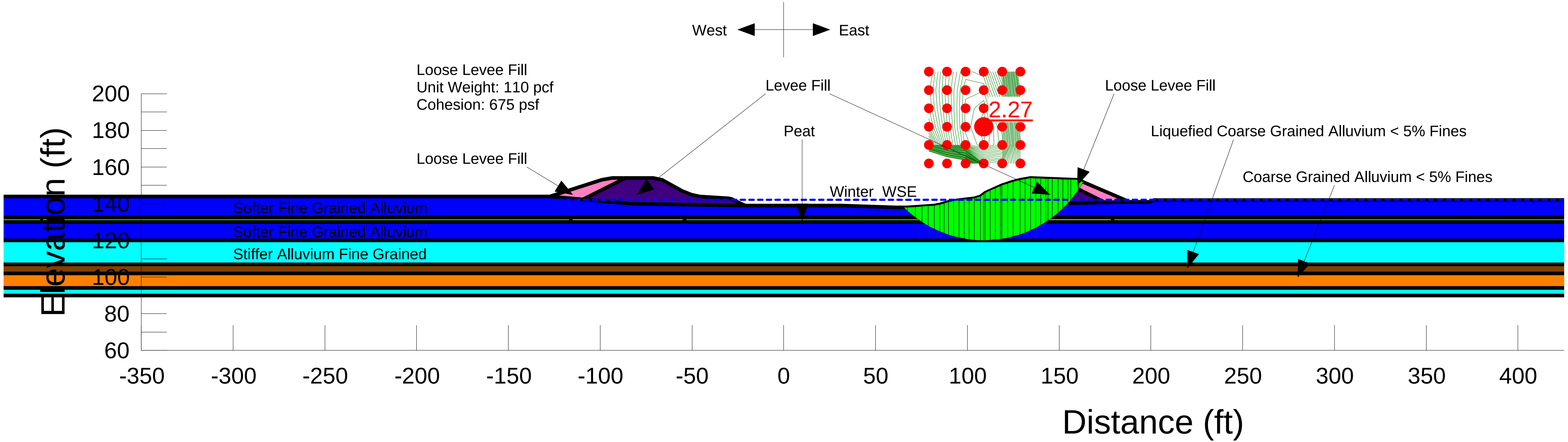


FIGURE G-4

Lower Llagas Creek Capacity Restoration Capital Project

Station 78+00 Landside Seismic Stability Analysis - West Levee

Model stratigraphy and characteristics developed using geologic information
from B-078+00W, CPT-078+00W, and CPT-074+50E
Topography based on 2007 LiDAR data provided by SCVWD for Project use
Design Water Surface Elevation (Design WSE) provided by SCVWD
All elevations reference North American Vertical Datum of 1988 (NAVD 1988)

Analysis Section Details

Winter WSE - 145.0'

West Levee

Crest Elevation	163.0'
Crest Width	56.0'
Waterside Slope	2.3H:1V
Waterside Toe Elevation	142.0'
Landside Slope	2.7H:1V
Landside Toe Elevation	147.0'
Factor of Safety	2.60

Levee Fill
Unit Weight: 115 pcf
Cohesion: 1190 psf

Peat
Unit Weight: 70 pcf
Cohesion: 565 psf

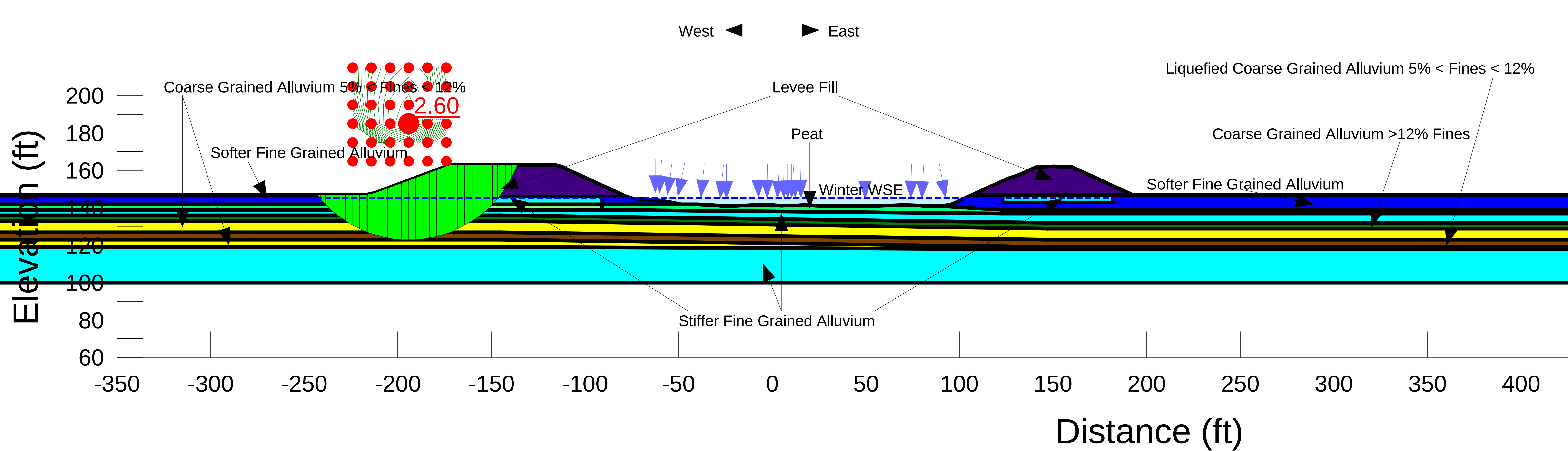
Coarse Grained Alluvium >12% Fines
Unit Weight: 120 pcf
Cohesion: 0 psf
Phi: 32 °

Softer Fine Grained Alluvium
Unit Weight: 110 pcf
Cohesion: 560 psf

Stiffer Fine Grained Alluvium
Unit Weight: 120 pcf
Cohesion: 1025 psf

Coarse Grained Alluvium 5% < Fines < 12%
Unit Weight: 140 pcf
Cohesion: 0 psf
Phi: 35 °

Liquefied Coarse Grained Alluvium 5% < Fines < 12%
Unit Weight: 140 pcf
Cohesion: 400 psf



West
East
Liquefied Coarse Grained Alluvium 5% < Fines < 12%
Coarse Grained Alluvium 5% < Fines < 12%
Levee Fill
2.60
Peat
Coarse Grained Alluvium >12% Fines
Softer Fine Grained Alluvium
Softer Fine Grained Alluvium
Winter WSE
Stiffer Fine Grained Alluvium
200
180
160
140
120
100
80
60
Elevation (ft)
-350
-300
-250
-200
-150
-100
-50
0
50
100
150
200
250
300
350
400
Distance (ft)

FIGURE G-5

Lower Llagas Creek Capacity Restoration Capital Project

Station 78+00 Waterside Seismic Stability Analysis - West Levee

Model stratigraphy and characteristics developed using geologic information
from B-078+00W, CPT-078+00W, and CPT-074+50E
Topography based on 2007 LiDAR data provided by SCVWD for Project use
Design Water Surface Elevation (Design WSE) provided by SCVWD
All elevations reference North American Vertical Datum of 1988 (NAVD 1988)

Analysis Section Details
Winter WSE - 145.0'

West Levee

Levee Fill
Unit Weight: 115 pcf
Cohesion: 1190 psf

Peat
Unit Weight: 70 pcf
Cohesion: 565 psf

Coarse Grained Alluvium >12% Fines
Unit Weight: 120 pcf
Cohesion: 0 psf
Phi: 32 °

Crest Elevation	163.0'
Crest Width	56.0'
Waterside Slope	2.3H:1V
Waterside Toe Elevation	142.0'
Landside Slope	2.7H:1V
Landside Toe Elevation	147.0'
Factor of Safety	2.19

Softer Fine Grained Alluvium
Unit Weight: 110 pcf
Cohesion: 560 psf

Stiffer Fine Grained Alluvium
Unit Weight: 120 pcf
Cohesion: 1025 psf

Coarse Grained Alluvium 5% < Fines < 12%
Unit Weight: 140 pcf
Cohesion: 0 psf
Phi: 35 °

Liquefied Coarse Grained Alluvium 5% < Fines < 12%
Unit Weight: 140 pcf
Cohesion: 400 psf

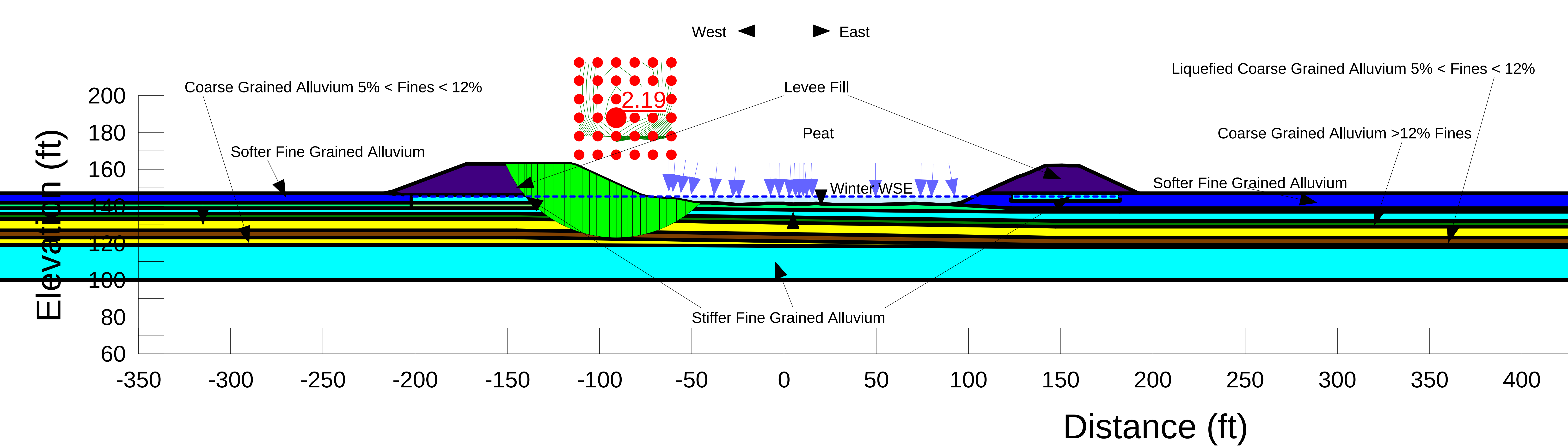

West
East
2.19
Coarse Grained Alluvium 5% < Fines < 12%
Softer Fine Grained Alluvium
Levee Fill
Peat
Winter WSE
Liquefied Coarse Grained Alluvium 5% < Fines < 12%
Coarse Grained Alluvium >12% Fines
Softer Fine Grained Alluvium
Stiffer Fine Grained Alluvium
Elevation (ft)
200
180
160
140
120
100
80
60
-350
-300
-250
-200
-150
-100
-50
0
50
100
150
200
250
300
350
400
Distance (ft)

FIGURE G-6

Lower Llagas Creek Capacity Restoration Capital Project

Station 78+00 Landside Seismic Stability Analysis - East Levee

Model stratigraphy and characteristics developed using geologic information
from B-078+00W, CPT-078+00W, and CPT-074+50E
Topography based on 2007 LiDAR data provided by SCVWD for Project use
Design Water Surface Elevation (Design WSE) provided by SCVWD
All elevations reference North American Vertical Datum of 1988 (NAVD 1988)

Analysis Section Details
Winter WSE - 145.0'

East Levee

Levee Fill
Unit Weight: 115 pcf
Cohesion: 1190 psf

Peat
Unit Weight: 70 pcf
Cohesion: 565 psf

Coarse Grained Alluvium >12% Fines
Unit Weight: 120 pcf
Cohesion: 0 psf
Phi: 32 °

Crest Elevation	162.2'
Crest Width	18.2'
Waterside Slope	2.3H:1V
Waterside Toe Elevation	141.0'
Landside Slope	2.2H:1V
Landside Toe Elevation	147.0'
Factor of Safety	2.62

Softer Fine Grained Alluvium
Unit Weight: 110 pcf
Cohesion: 560 psf

Stiffer Fine Grained Alluvium
Unit Weight: 120 pcf
Cohesion: 1025 psf

Coarse Grained Alluvium 5% < Fines < 12%
Unit Weight: 140 pcf
Cohesion: 0 psf
Phi: 35 °

Liquefied Coarse Grained Alluvium 5% < Fines < 12%
Unit Weight: 140 pcf
Cohesion: 400 psf

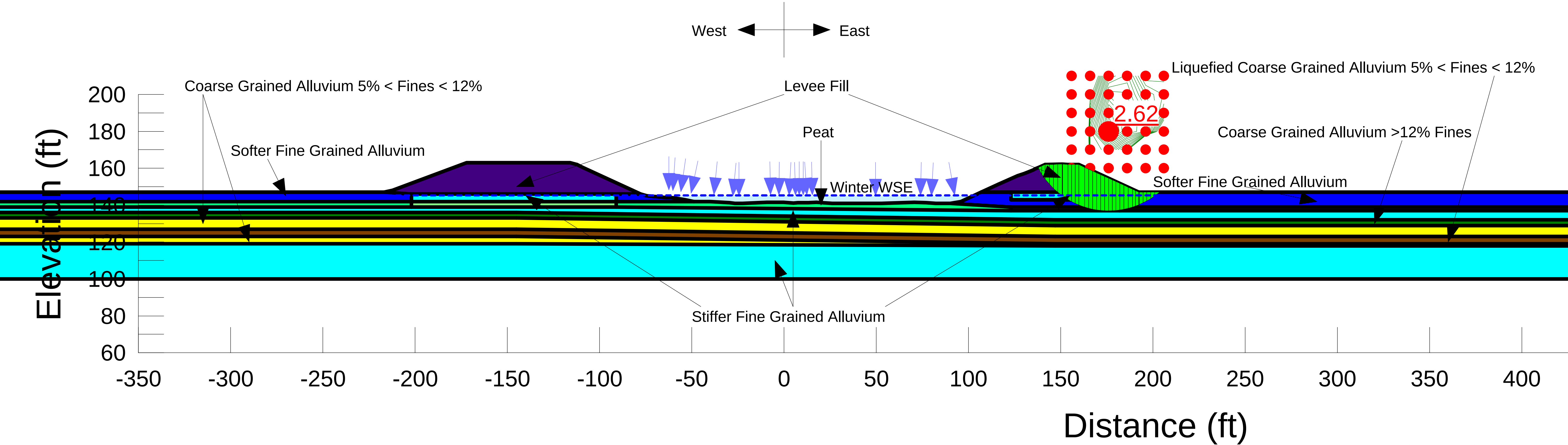


FIGURE G-7

Lower Llagas Creek Capacity Restoration Capital Project

Station 78+00 Waterside Seismic Stability Analysis - East Levee

Model stratigraphy and characteristics developed using geologic information
from B-078+00W, CPT-078+00W, and CPT-074+50E
Topography based on 2007 LiDAR data provided by SCVWD for Project use
Design Water Surface Elevation (Design WSE) provided by SCVWD
All elevations reference North American Vertical Datum of 1988 (NAVD 1988)

Analysis Section Details

Winter WSE - 145.0'

East Levee

Crest Elevation	162.2'
Crest Width	18.2'
Waterside Slope	2.3H:1V
Waterside Toe Elevation	141.0'
Landside Slope	2.2H:1V
Landside Toe Elevation	147.0'
Factor of Safety	2.14

Levee Fill
Unit Weight: 115 pcf
Cohesion: 1190 psf

Peat
Unit Weight: 70 pcf
Cohesion: 565 psf

Coarse Grained Alluvium >12% Fines
Unit Weight: 120 pcf
Cohesion: 0 psf
Phi: 32 °

Softer Fine Grained Alluvium
Unit Weight: 110 pcf
Cohesion: 560 psf

Stiffer Fine Grained Alluvium
Unit Weight: 120 pcf
Cohesion: 1025 psf

Coarse Grained Alluvium 5% < Fines < 12%
Unit Weight: 140 pcf
Cohesion: 0 psf
Phi: 35 °

Liquefied Coarse Grained Alluvium 5% < Fines < 12%
Unit Weight: 140 pcf
Cohesion: 400 psf

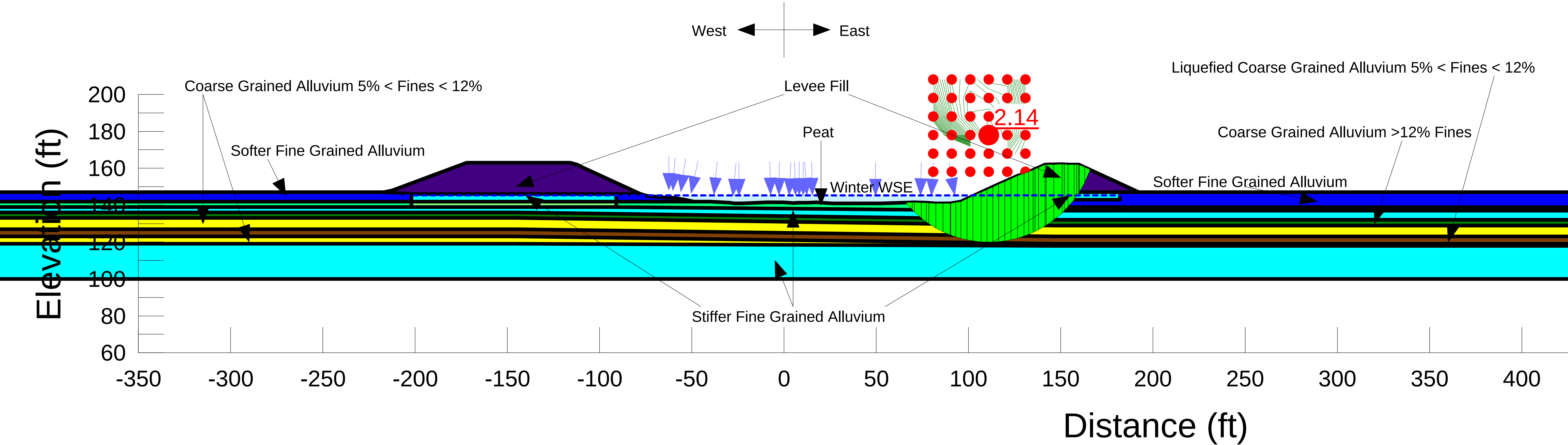

West
East
Liquefied Coarse Grained Alluvium 5% < Fines < 12%
Coarse Grained Alluvium 5% < Fines < 12%
Levee Fill
2.14
Peat
Coarse Grained Alluvium >12% Fines
Softer Fine Grained Alluvium
Winter WSE
Softer Fine Grained Alluvium
Stiffer Fine Grained Alluvium
Elevation (ft)
200
180
160
140
120
100
80
60
-350
-300
-250
-200
-150
-100
-50
0
50
100
150
200
250
300
350
400
Distance (ft)

FIGURE G-8

Lower Llagas Creek Capacity Restoration Capital Project

Station 92+50 Landside Seismic Stability Analysis - West Levee

Model stratigraphy and characteristics developed using geologic information
from B-092+50W, B-092+50E, and CPT-092+50E
Topography based on 2007 LiDAR data provided by SCVWD for Project ues
Design Water Surface Elevation (Design WSE) provided by SCVWD
All elevations reference North American Vertical Datum of 1988 (NAVD88)

Analysis Section Details

Winter WSE - 147.0'

West Levee

Levee Fill
Unit Weight: 115 pcf
Cohesion: 1150 psf

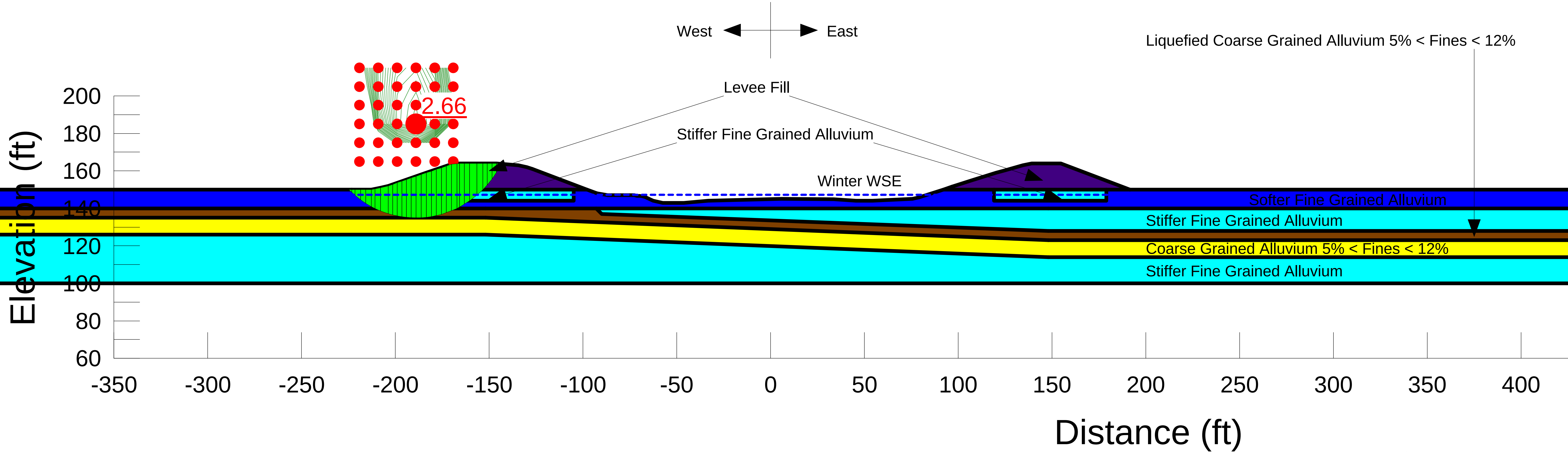
Stiffer Fine Grained Alluvium
Unit Weight: 120 pcf
Cohesion: 1020 psf

Coarse Grained Alluvium 5% < Fines < 12%
Unit Weight: 140 pcf
Cohesion: 0 psf
Phi: 35 °

Softer Fine Grained Alluvium
Unit Weight: 110 pcf
Cohesion: 650 psf

Liquefied Coarse Grained Alluvium 5% < Fines < 12%
Unit Weight: 140 pcf
Cohesion: 500 psf

Crest Elevation	164.0'
Crest Width	24.0'
Waterside Slope	2.8H:1V
Waterside Toe Elevation	143.0'
Landside Slope	3.2H:1V
Landside Toe Elevation	150.0'
Factor of Safety	2.66



West
East
Liquefied Coarse Grained Alluvium 5% < Fines < 12%
Levee Fill
Stiffer Fine Grained Alluvium
Winter WSE
2.66
Softer Fine Grained Alluvium
Stiffer Fine Grained Alluvium
Coarse Grained Alluvium 5% < Fines < 12%
Stiffer Fine Grained Alluvium
Elevation (ft)
200
180
160
140
120
100
80
60
-350
-300
-250
-200
-150
-100
-50
0
50
100
150
200
250
300
350
400
Distance (ft)

FIGURE G-9

Lower Llagas Creek Capacity Restoration Capital Project

Station 92+50 Waterside Seismic Stability Analysis - West Levee

Model stratigraphy and characteristics developed using geologic information
from B-092+50W, B-092+50E, and CPT-092+50E
Topography based on 2007 LiDAR data provided by SCVWD for Project ues
Design Water Surface Elevation (Design WSE) provided by SCVWD
All elevations reference North American Vertical Datum of 1988 (NAVD88)

Analysis Section Details

Winter WSE - 147.0'

West Levee

Levee Fill
Unit Weight: 115 pcf
Cohesion: 1150 psf

Stiffer Fine Grained Alluvium
Unit Weight: 120 pcf
Cohesion: 1020 psf

Coarse Grained Alluvium 5% < Fines < 12%
Unit Weight: 140 pcf
Cohesion: 0 psf
Phi: 35 °

Softer Fine Grained Alluvium
Unit Weight: 110 pcf
Cohesion: 650 psf

Liquefied Coarse Grained Alluvium 5% < Fines < 12%
Unit Weight: 140 pcf
Cohesion: 500 psf

Crest Elevation	164.0'
Crest Width	24.0'
Waterside Slope	2.8H:1V
Waterside Toe Elevation	143.0'
Landside Slope	3.2H:1V
Landside Toe Elevation	150.0'
Factor of Safety	2.29

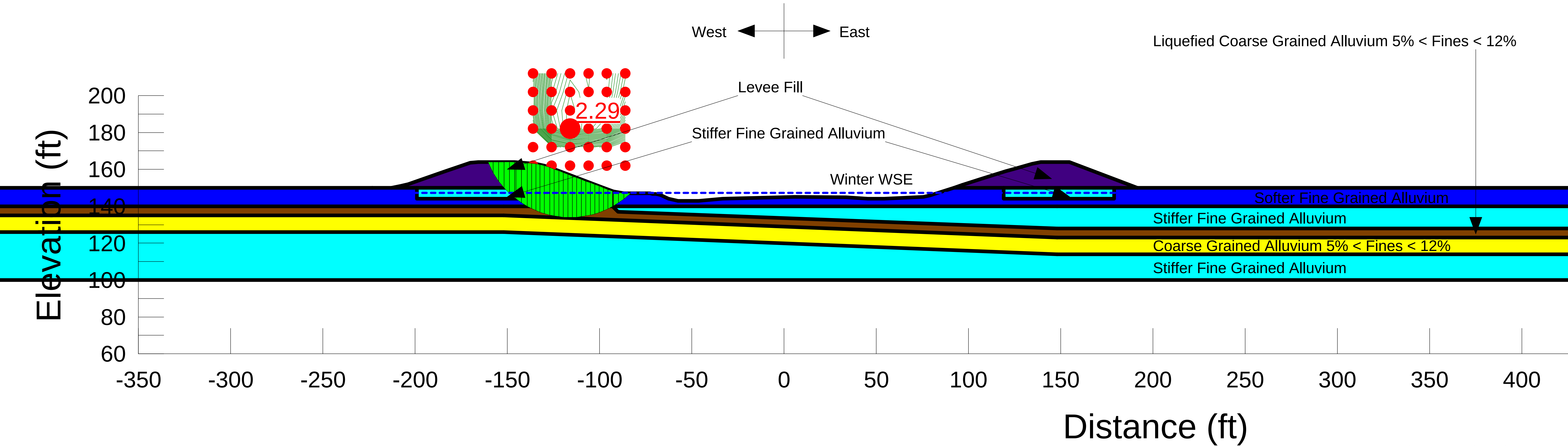

West
East
Liquefied Coarse Grained Alluvium 5% < Fines < 12%
Levee Fill
Stiffer Fine Grained Alluvium
2.29
Winter WSE
Softer Fine Grained Alluvium
Stiffer Fine Grained Alluvium
Coarse Grained Alluvium 5% < Fines < 12%
Stiffer Fine Grained Alluvium
Elevation (ft)
200
180
160
140
120
100
80
60
-350
-300
-250
-200
-150
-100
-50
0
50
100
150
200
250
300
350
400
Distance (ft)

FIGURE G-10

Lower Llagas Creek Capacity Restoration Capital Project

Station 92+50 Landside Seismic Stability Analysis - East Levee

Model stratigraphy and characteristics developed using geologic information
from B-092+50W, B-092+50E, and CPT-092+50E
Topography based on 2007 LiDAR data provided by SCVWD for Project ues
Design Water Surface Elevation (Design WSE) provided by SCVWD
All elevations reference North American Vertical Datum of 1988 (NAVD88)

Analysis Section Details

Winter WSE - 147.0'

East Levee

Crest Elevation	164.0'
Crest Width	15.6'
Waterside Slope	3.2H:1V
Waterside Toe Elevation	144.0'
Landside Slope	2.6H:1V
Landside Toe Elevation	150.0'
Factor of Safety	2.87

Levee Fill
Unit Weight: 115 pcf
Cohesion: 1150 psf

Stiffer Fine Grained Alluvium
Unit Weight: 120 pcf
Cohesion: 1020 psf

Coarse Grained Alluvium 5% < Fines < 12%
Unit Weight: 140 pcf
Cohesion: 0 psf
Phi: 35 °

Softer Fine Grained Alluvium
Unit Weight: 110 pcf
Cohesion: 650 psf

Liquefied Coarse Grained Alluvium 5% < Fines < 12%
Unit Weight: 140 pcf
Cohesion: 500 psf

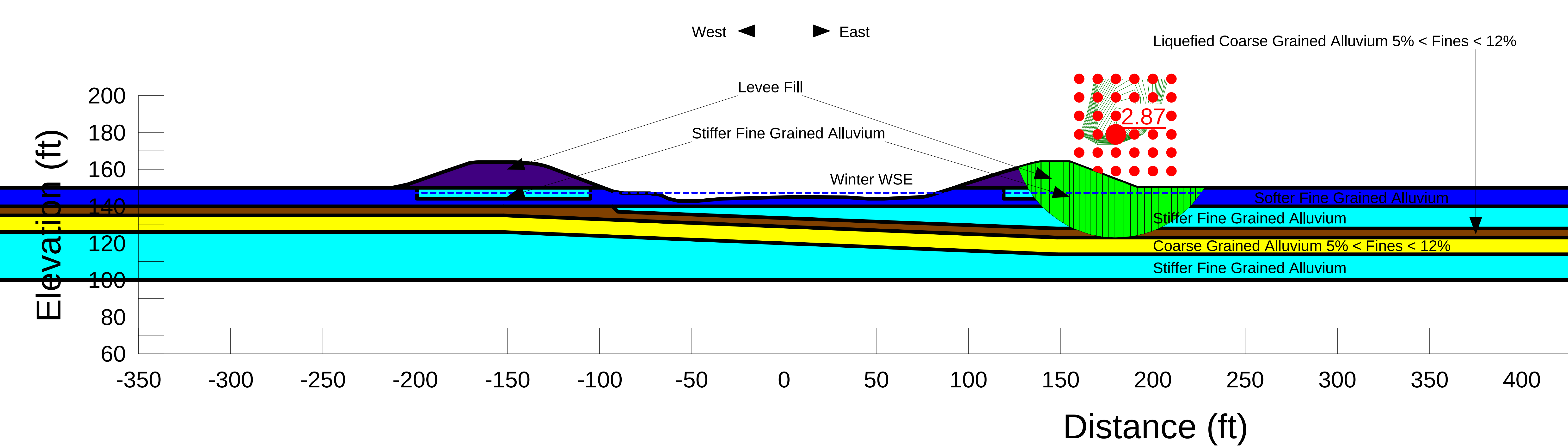

West
East
Liquefied Coarse Grained Alluvium 5% < Fines < 12%
Levee Fill
2.87
Stiffer Fine Grained Alluvium
Winter WSE
Softer Fine Grained Alluvium
Stiffer Fine Grained Alluvium
Coarse Grained Alluvium 5% < Fines < 12%
Stiffer Fine Grained Alluvium
Elevation (ft)
200
180
160
140
120
100
80
60
-350
-300
-250
-200
-150
-100
-50
0
50
100
150
200
250
300
350
400
Distance (ft)

FIGURE G-11

Lower Llagas Creek Capacity Restoration Capital Project

Station 92+50 Waterside Seismic Stability Analysis - East Levee

Model stratigraphy and characteristics developed using geologic information
from B-092+50W, B-092+50E, and CPT-092+50E
Topography based on 2007 LiDAR data provided by SCVWD for Project ues
Design Water Surface Elevation (Design WSE) provided by SCVWD
All elevations reference North American Vertical Datum of 1988 (NAVD88)

Analysis Section Details

Winter WSE - 147.0'

East Levee

Levee Fill
Unit Weight: 115 pcf
Cohesion: 1150 psf

Stiffer Fine Grained Alluvium
Unit Weight: 120 pcf
Cohesion: 1020 psf

Coarse Grained Alluvium 5% < Fines < 12%
Unit Weight: 140 pcf
Cohesion: 0 psf
Phi: 35 °

Softer Fine Grained Alluvium
Unit Weight: 110 pcf
Cohesion: 650 psf

Liquefied Coarse Grained Alluvium 5% < Fines < 12%
Unit Weight: 140 pcf
Cohesion: 500 psf

Crest Elevation	164.0'
Crest Width	15.6'
Waterside Slope	3.2H:1V
Waterside Toe Elevation	144.0'
Landside Slope	2.6H:1V
Landside Toe Elevation	150.0'
Factor of Safety	2.22

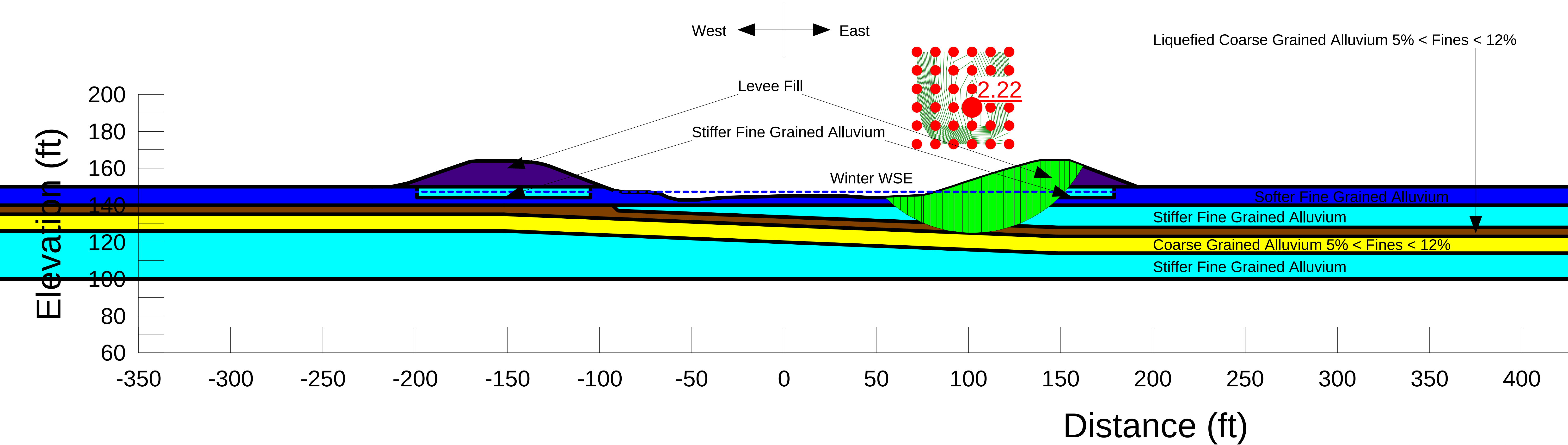


FIGURE G-12

Lower Llagas Creek Capacity Restoration Capital Project

Station 106+50 Landside Seismic Stability Analysis - West Levee

Model stratigraphy and characteristics developed using geologic information
from B-107+00W, CPT-107+00W, and CPT-108+50E
Topography based on 2007 LiDAR data provided by SCVWD for Project use
Design Water Surface Elevation (Design WSE) provided by SCVWD
All elevations reference North American Vertical Datum of 1988 (NAVD88)

Analysis Section Details

Winter WSE - 149.0'

West Levee

Levee Fill
Unit Weight: 115 pcf
Cohesion: 1100 psf

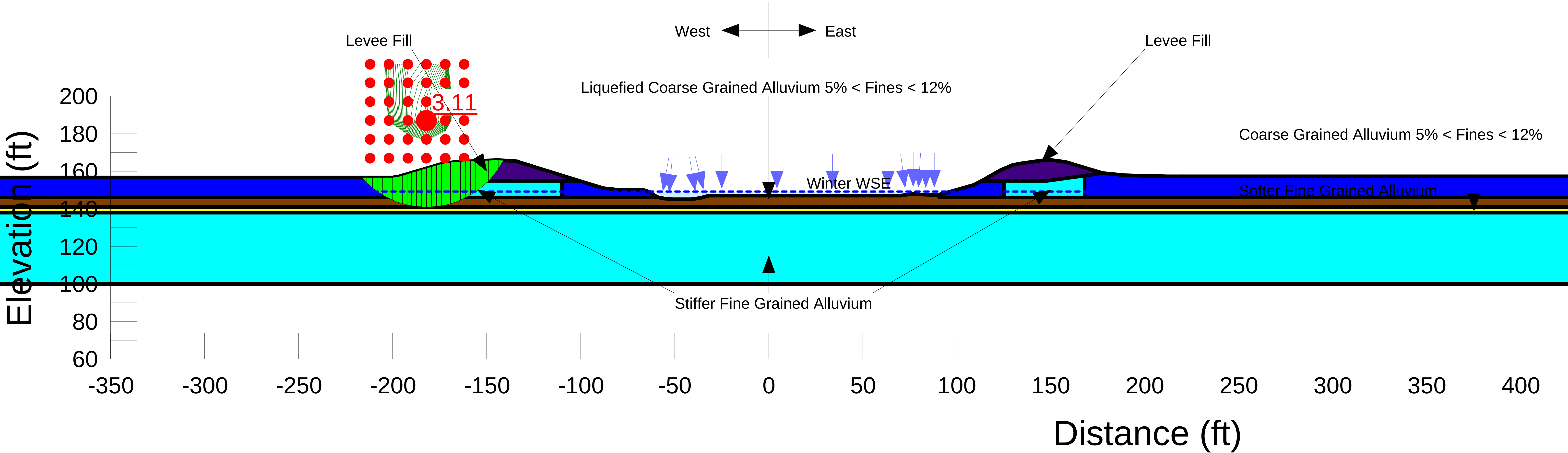
Stiffer Fine Grained Alluvium
Unit Weight: 120 pcf
Cohesion: 1000 psf

Coarse Grained Alluvium 5% < Fines < 12%
Unit Weight: 140 pcf
Cohesion: 0 psf
Phi: 35 °

Crest Elevation	166.0'
Crest Width	34.0'
Waterside Slope	3.2H:1V
Waterside Toe Elevation	145.0'
Landside Slope	3.3H:1V
Landside Toe Elevation	156.7'
Factor of Safety	3.11

Softer Fine Grained Alluvium
Unit Weight: 110 pcf
Cohesion: 500 psf

Liquefied Coarse Grained Alluvium 5% < Fines < 12%
Unit Weight: 140 pcf
Cohesion: 250 psf



Levee Fill
West
East
Levee Fill
Liquefied Coarse Grained Alluvium 5% < Fines < 12%
3.11
Coarse Grained Alluvium 5% < Fines < 12%
Winter WSE
Softer Fine Grained Alluvium
Stiffer Fine Grained Alluvium
Elevation (ft)
200
180
160
140
120
100
80
60
-350
-300
-250
-200
-150
-100
-50
0
50
100
150
200
250
300
350
400
Distance (ft)

FIGURE G-13

Lower Llagas Creek Capacity Restoration Capital Project

Station 106+50 Waterside Seismic Stability Analysis - West Levee

Model stratigraphy and characteristics developed using geologic information
from B-107+00W, CPT-107+00W, and CPT-108+50E
Topography based on 2007 LiDAR data provided by SCVWD for Project use
Design Water Surface Elevation (Design WSE) provided by SCVWD
All elevations reference North American Vertical Datum of 1988 (NAVD88)

Analysis Section Details

Winter WSE - 149.0'

West Levee

Levee Fill
Unit Weight: 115 pcf
Cohesion: 1100 psf

Stiffer Fine Grained Alluvium
Unit Weight: 120 pcf
Cohesion: 1000 psf

Coarse Grained Alluvium 5% < Fines < 12%
Unit Weight: 140 pcf
Cohesion: 0 psf
Phi: 35 °

Crest Elevation	166.0'
Crest Width	34.0'
Waterside Slope	3.2H:1V
Waterside Toe Elevation	145.0'
Landside Slope	3.3H:1V
Landside Toe Elevation	156.7'
Factor of Safety	2.13

Softer Fine Grained Alluvium
Unit Weight: 110 pcf
Cohesion: 500 psf

Liquefied Coarse Grained Alluvium 5% < Fines < 12%
Unit Weight: 140 pcf
Cohesion: 250 psf

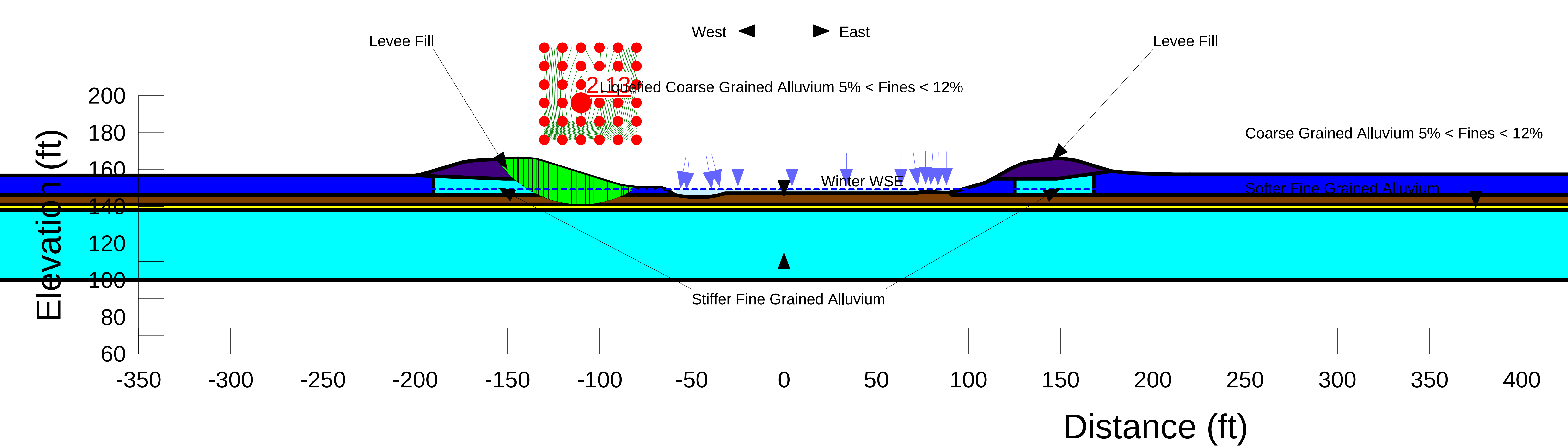

West
East
Levee Fill
Levee Fill
2.13
Liquefied Coarse Grained Alluvium 5% < Fines < 12%
Coarse Grained Alluvium 5% < Fines < 12%
Winter WSE
Softer Fine Grained Alluvium
Stiffer Fine Grained Alluvium
200
180
160
140
120
100
80
60
Elevation (ft)
-350
-300
-250
-200
-150
-100
-50
0
50
100
150
200
250
300
350
400
Distance (ft)

FIGURE G-14

Lower Llagas Creek Capacity Restoration Capital Project

Station 106+50 Landside Seismic Stability Analysis - East Levee

Model stratigraphy and characteristics developed using geologic information
from B-107+00W, CPT-107+00W, and CPT-108+50E
Topography based on 2007 LiDAR data provided by SCVWD for Project use
Design Water Surface Elevation (Design WSE) provided by SCVWD
All elevations reference North American Vertical Datum of 1988 (NAVD88)

Analysis Section Details

Winter WSE - 149.0'

East Levee

Levee Fill
Unit Weight: 115 pcf
Cohesion: 1100 psf

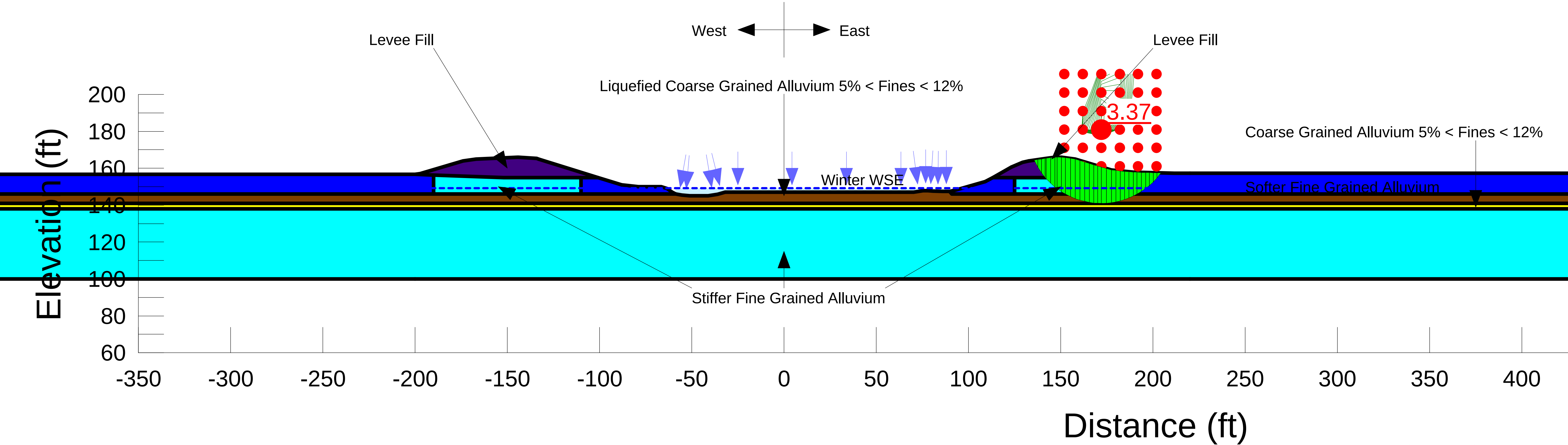
Stiffer Fine Grained Alluvium
Unit Weight: 120 pcf
Cohesion: 1000 psf

Coarse Grained Alluvium 5% < Fines < 12%
Unit Weight: 140 pcf
Cohesion: 0 psf
Phi: 35 °

Crest Elevation	166.0'
Crest Width	15.7'
Waterside Slope	2.1H:1V
Waterside Toe Elevation	147.5'
Landside Slope	3.3H:1V
Landside Toe Elevation	157.2'
Factor of Safety	3.37

Softer Fine Grained Alluvium
Unit Weight: 110 pcf
Cohesion: 500 psf

Liquefied Coarse Grained Alluvium 5% < Fines < 12%
Unit Weight: 140 pcf
Cohesion: 250 psf



Levee Fill
West
East
Levee Fill
Liquefied Coarse Grained Alluvium 5% < Fines < 12%
3.37
Coarse Grained Alluvium 5% < Fines < 12%
Winter WSE
Softer Fine Grained Alluvium
Stiffer Fine Grained Alluvium
Elevation (ft)
200
180
160
140
120
100
80
60
-350
-300
-250
-200
-150
-100
-50
0
50
100
150
200
250
300
350
400
Distance (ft)

FIGURE G-15

Lower Llagas Creek Capacity Restoration Capital Project

Station 106+50 Waterside Seismic Stability Analysis - East Levee

Model stratigraphy and characteristics developed using geologic information
from B-107+00W, CPT-107+00W, and CPT-108+50E
Topography based on 2007 LiDAR data provided by SCVWD for Project use
Design Water Surface Elevation (Design WSE) provided by SCVWD
All elevations reference North American Vertical Datum of 1988 (NAVD88)

Analysis Section Details

Winter WSE - 149.0'

East Levee

Crest Elevation	166.0'
Crest Width	15.7'
Waterside Slope	2.1H:1V
Waterside Toe Elevation	147.5'
Landside Slope	3.3H:1V
Landside Toe Elevation	157.2'
Factor of Safety	1.77

Levee Fill
Unit Weight: 115 pcf
Cohesion: 1100 psf

Stiffer Fine Grained Alluvium
Unit Weight: 120 pcf
Cohesion: 1000 psf

Coarse Grained Alluvium 5% < Fines < 12%
Unit Weight: 140 pcf
Cohesion: 0 psf
Phi: 35 °

Softer Fine Grained Alluvium
Unit Weight: 110 pcf
Cohesion: 500 psf

Liquefied Coarse Grained Alluvium 5% < Fines < 12%
Unit Weight: 140 pcf
Cohesion: 250 psf

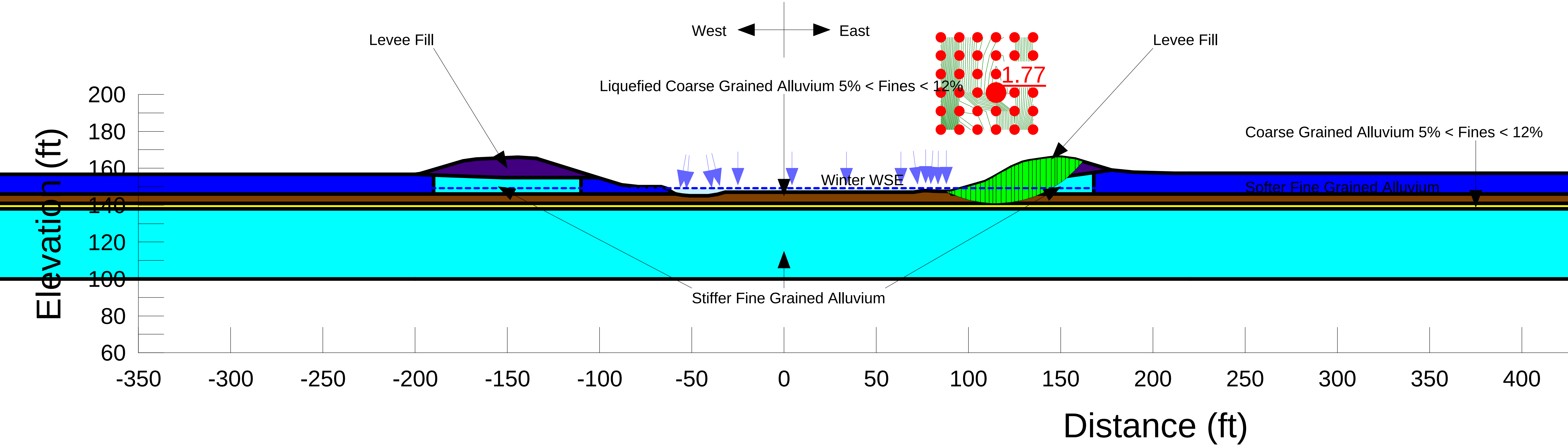

Levee Fill
West
East
Levee Fill
1.77
Liquefied Coarse Grained Alluvium 5% < Fines < 12%
Coarse Grained Alluvium 5% < Fines < 12%
Winter WSE
Softer Fine Grained Alluvium
Stiffer Fine Grained Alluvium
Elevation (ft)
200
180
160
140
120
100
80
60
-350
-300
-250
-200
-150
-100
-50
0
50
100
150
200
250
300
350
400
Distance (ft)

FIGURE G-16

Appendix H

Settlement Evaluation

Client: Santa Clara Valley Water District
Project: Lower Llagas Creek Capacity Restoration Capital Project
Project No.: 11540-0

Prepared By: T. Haynes/ Len Sansone
Date: 6/25/12
Checked By: L. Sansone
Date: 6/27/12

Settlement Evaluation

Table of Contents:

Settlement Evaluation Text

Figures

Figures H-1 to H-4	Levee Stratigraphy for Station 50+00, Station 92+50 West Levee, Station 92+50 East Levee, and Station 106+50
Figures H-5 to H-8	Hand Calculations for Station 50+00 Station, 92+50 West Levee, Station 92+50 East Levee, and Station 106+50

Purpose

Estimate the potential settlement caused by conceptual-level, freeboard mitigation loading on the Lower Llagas Creek levees. Perform settlement calculations in general accordance with USACE Engineering Manual EM 1110-1-1904, Settlment Analysis.

Assumptions

- In order to evaluate settlements at the feasibility design level, we assumed a conceptual level configuration for the levee fill raise option at Station 50+00, Station 92+50, and Station 106+50. The additional fill is the maximum fill section assumed for mitigation of levee freeboard assuming an earthfill raise option is selected for the final design. Refer to **Figures H-1 to H-4**, which show a conceptual level configuration for the levee fill raise option at Station 50+00, Station 92+50 West Levee, Station 92+50 East Levee, and Station 106+50.
- For the feasibility design level evaluation, the additional load on the foundation soils due to the earthfill raise option was modeled conservatively as an areal-type loading condition with no dissipation of load influence on the foundation soils with depth.
- Primary and secondary settlement due to the original levee fill placement has already occurred.

Approach

1. Develop subsurface profile at a representative cross-section of the levee. Select points along the cross-section, as shown on **Figures H-1 to H-4**. The generalized stratigraphy modeled at Station 50+00 was determined to be the critical section stratigraphy for the Llagas Creek alignment due to the presence of thin peat layers and thicker softer grained alluvium materials at Station 50+00. These materials are potentially compressible under additional loading from construction of freeboard mitigation features.
2. Assign soil parameters and overconsolidation ratio, as shown on **Figures H-1 to H-4**. Settlement parameters for the Softer and Stiffer Fine Grained Alluvium foundation soils and existing Levee Fill were estimated from CPT Correlations and empirical correlations to index tests (Kulhawy and Mayne 1990 and Coduto 1999) and confirmed with consolidation test results shown in **Appendix C**. The settlement parameters for the peat material are based on a literature review of typical peat parameters (Mesri and Ajilouni 2007).
3. Perform a hand calculation to estimate settlement due to primary consolidation, as shown on **Figures H-5 to H-8**. Individual soil units were broken up into sublayers of approximately equal thickness for calculation purposes. Sublayer thicknesses generally ranged from 2 to 5 feet. Engineering judgment was applied to determine the number of sub layers and thickness for a given soil unit. The results indicate a primary consolidation settlement between 2 and 9 inches beneath the existing levee based on the areal loading assumptions described above. This assumption will be refined when a preferred alternative is selected and the loading conditions associated with this alternative are better defined.

Client:	Santa Clara Valley Water District	**Prepared By:**	T. Haynes/ Len Sansone
Project:	Lower Llagas Creek Capacity Restoration Capital Project	**Date:**	6/25/12
Project No.:	11540-0	**Checked By:**	L. Sansone
	Settlement Evaluation	**Date:**	6/27/12

Consolidation Terminology

$CR = C_c/(1+e_0)$

where:

CR is the compression ratio
C_c is the compression index
e_0 is the void ratio

$RR = C_r /(1+ e_0)$

where:

RR is the recompression ratio
C_r is the recompression index
e_0 is the void ratio

The compression index and the recompression index for the Softer and Stiffer Fine Grained Alluvium soils and existing Levee Fill were estimated using the following empirical correlations (Kulhawy and Mayne 1990):

$C_c = 0.5^* G_s (PI/100)$

where:

G_s is the specific gravity; 2.8 for the Softer Fine Grained Alluvium and Levee Fill and 2.7 for the Stiffer Fine Grained Alluvium
PI is the plasticity index; estimated as the average of the maximum and average values discussed in **Attachment 1** of **Appendix F**

$C_r = C_c(1-\Lambda)$

where:

Λ is the critical state parameter; a typical value for clays of 0.8 was selected

The compression index for the Peat was estimated using the following empirical correlation (Mesri and Ajilouni 2007):

$C_c = w_0/100$

where:

w_0 is the water content; discussed in **Attachment 2** of **Appendix F**.

The void ratio for the Softer and Stiffer Fine Grained Alluvium foundation soils, existing Levee Fill, Peats were estimated using the following empirical correlations (Coduto 1999):

$$e_0 = [G_s\gamma_w/\gamma_d]-1$$

where:

e_0 is the void ratio

G_s is the specific gravity; 2.8 for the Softer Fine Grained Alluvium and Levee Fill, 2.7 for the Stiffer Fine Grained Alluvium, and 1.5 for the Peat

γ_w is the unit weight of water; 62.4 pcf

γ_d is the dry unit weight of soil; as discussed in **Attachment 1** of **Appendix F** for the Softer and Stiffer Fine Grained Alluvium soils and existing Levee Fill and in **Attachment 2** of **Appendix F** for the Peat

Primary Consolidation Settlement

Based on the soils either being normally consolidated or overconsolidated, where $\sigma'_{zf} < \sigma'_c$, the following equations were used to determine primary consolidation settlement:

For normally consolidated soils:

$$(\delta_c)_{ult} = \Sigma\, CR\, H \log(\sigma'_{zf}/\sigma'_{z0})$$

where:

$(\delta_c)_{ult}$ is the ultimate consolidation settlement at the ground surface,
CR is the compression ratio,
H is the thickness of the soil layer,
σ'_{zf} is the final vertical effective stress, and
σ'_{z0} is the intial vertical effective stress

For overconsolidated soils, where $\sigma'_{zf} < \sigma'_c$:

$$(\delta_c)_{ult} = \Sigma\, RR\, H \log(\sigma'_{zf}/\sigma'_{z0})$$

where:

$(\delta_c)_{ult}$ is the ultimate consolidation settlement at the ground surface,
RR is the recompression ratio,
H is the thickness of the soil layer,
σ'_{zf} is the final vertical effective stress, and
σ'_{z0} is the intial vertical effective stress

Client:	Santa Clara Valley Water District	**Prepared By:**	T. Haynes/ Len Sansone
Project:	Lower Llagas Creek Capacity Restoration Capital Project	**Date:**	6/25/12
Project No.:	11540-0	**Checked By:**	L. Sansone
		Date:	6/27/12

Settlement Evaluation

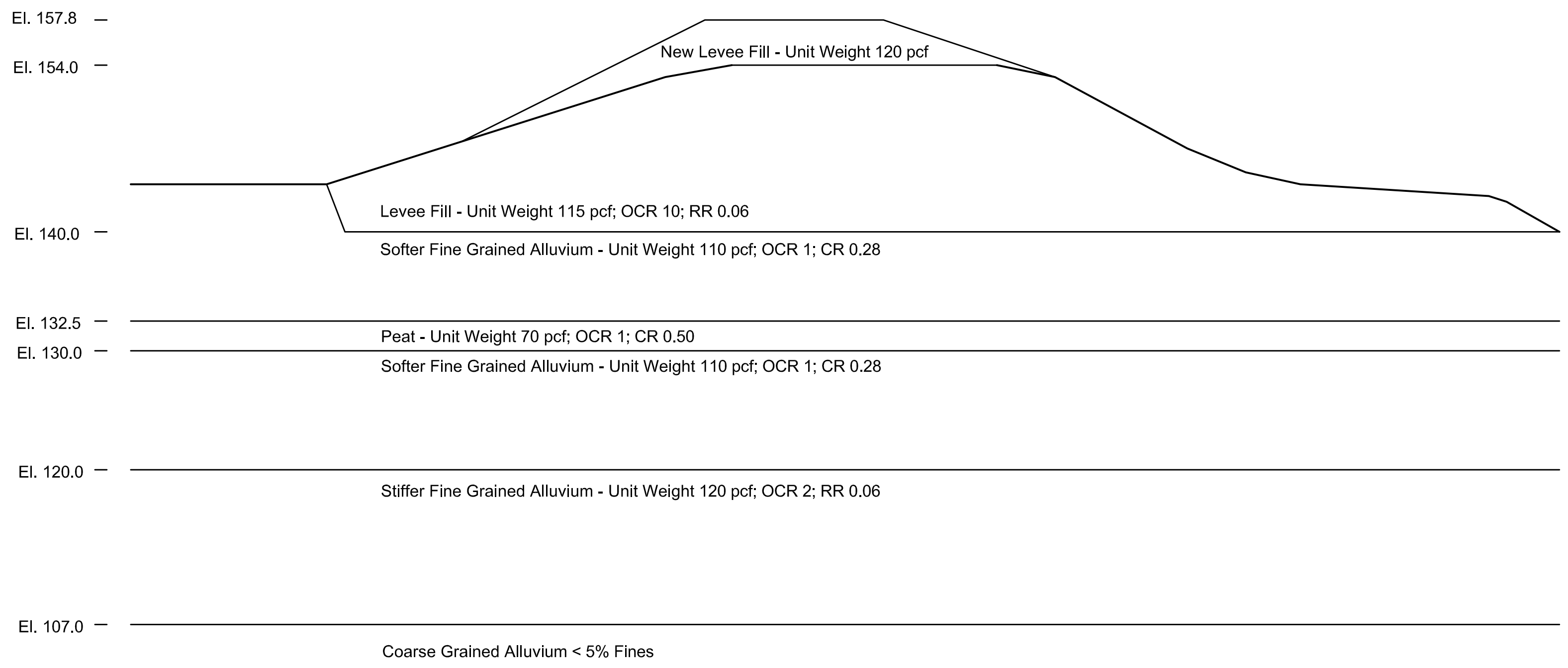
References:

U.S. Army Corps of Engineers (USACE), 1990, Settlement Analysis, Engineering Manual EM 1110-1-1904, September 30.

Kulhawy, F. and Mayne, P., 1990, Manual on Estimating Soil Properties for Foundation Design, Electrical Power Research Institute, August.

Coduto, D., 1999, Geotechnical Engineering Principles and Practices, Prentice Hall, Inc.

Mesri, G. and Ajlouni, M., 2007, Engineering Properties of Fibrous Peats, Journal of Geotechnical and Geoenvironmental Engineering, ASCE, Vol. 133, No. 7, pg. 850-866.


El. 157.8
El. 154.0
El. 140.0
El. 132.5
El. 130.0
El. 120.0
El. 107.0
New Levee Fill - Unit Weight 120 pcf
Levee Fill - Unit Weight 115 pcf; OCR 10; RR 0.06
Softer Fine Grained Alluvium - Unit Weight 110 pcf; OCR 1; CR 0.28
Peat - Unit Weight 70 pcf; OCR 1; CR 0.50
Softer Fine Grained Alluvium - Unit Weight 110 pcf; OCR 1; CR 0.28
Stiffer Fine Grained Alluvium - Unit Weight 120 pcf; OCR 2; RR 0.06
Coarse Grained Alluvium < 5% Fines

K:\11540-0 SCVWD Llagas Creek Geotech\Analyses\Llagas Creek Calc Packages\Appendix_Settlement\Figure H-1 to H-4 Typical Levee Stratigraphy.dwg

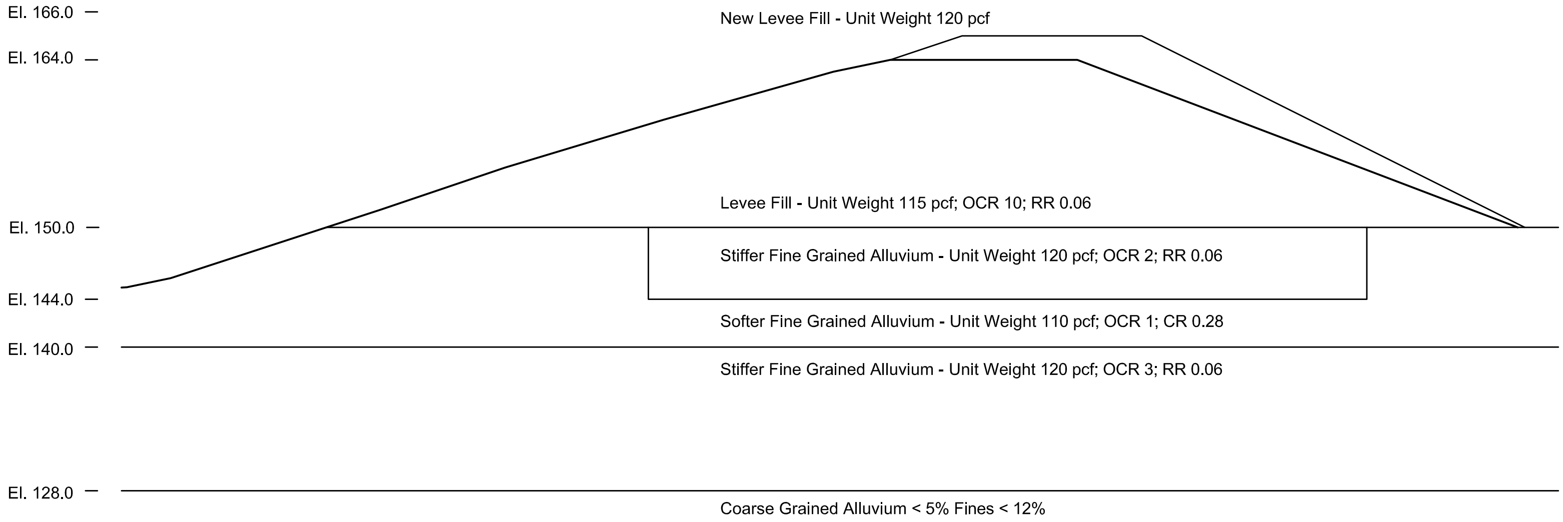
GEI Consultants

Lower Llagas Creek Capacity
Restoration Capital Project
Santa Clara County, California

GEI Project 11540-0

Station 50+00
Typical Levee
Stratigraphy

FIGURE
H-1


El. 166.0
El. 164.0
El. 150.0
El. 144.0
El. 140.0
El. 128.0
New Levee Fill - Unit Weight 120 pcf
Levee Fill - Unit Weight 115 pcf; OCR 10; RR 0.06
Stiffer Fine Grained Alluvium - Unit Weight 120 pcf; OCR 2; RR 0.06
Softer Fine Grained Alluvium - Unit Weight 110 pcf; OCR 1; CR 0.28
Stiffer Fine Grained Alluvium - Unit Weight 120 pcf; OCR 3; RR 0.06
Coarse Grained Alluvium < 5% Fines < 12%

K:\11540-0 SCVWD Llagas Creek Geotech\Analyses\Llagas Creek Calc
Packages\Appendix_Settlement\Figure H-1 to H-4 Typical Levee Stratigraphy.dwg

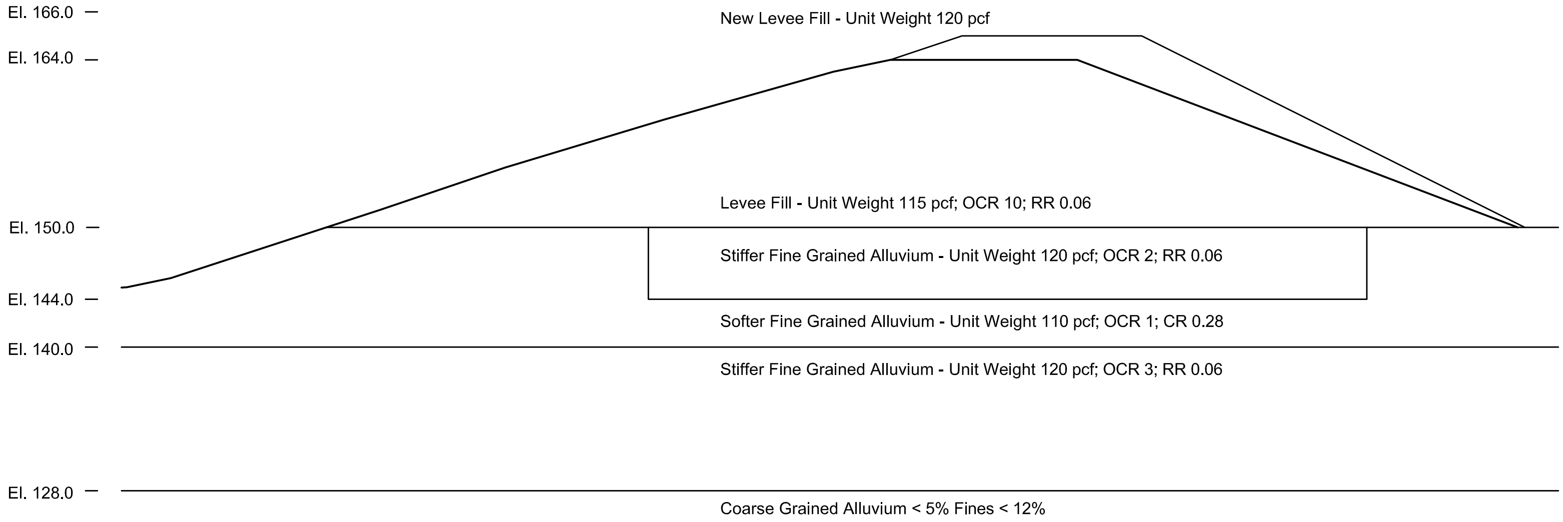
GEI Consultants

Lower Llagas Creek Capacity
Restoration Capital Project
Santa Clara County, California

GEI Project 11540-0

Station 92+50
West Levee
Stratigraphy

FIGURE
H-2


El. 166.0
El. 164.0
El. 150.0
El. 144.0
El. 140.0
El. 128.0
New Levee Fill - Unit Weight 120 pcf
Levee Fill - Unit Weight 115 pcf; OCR 10; RR 0.06
Stiffer Fine Grained Alluvium - Unit Weight 120 pcf; OCR 2; RR 0.06
Softer Fine Grained Alluvium - Unit Weight 110 pcf; OCR 1; CR 0.28
Stiffer Fine Grained Alluvium - Unit Weight 120 pcf; OCR 3; RR 0.06
Coarse Grained Alluvium < 5% Fines < 12%

K:\11540-0 SCVWD Llagas Creek Geotech\Analyses\Llagas Creek Calc
Packages\Appendix_Settlement\Figure H-1 to H-4 Typical Levee Stratigraphy.dwg

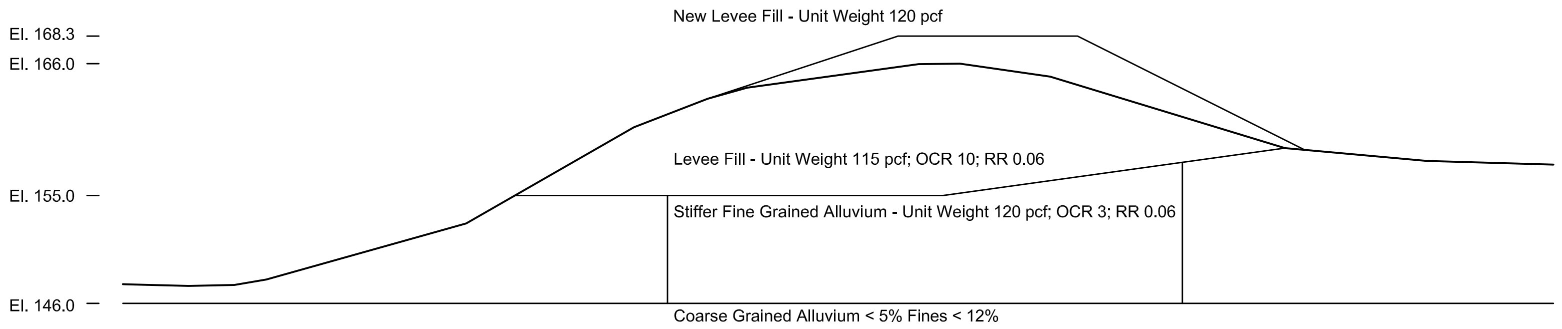
GEI Consultants

Lower Llagas Creek Capacity
Restoration Capital Project
Santa Clara County, California

GEI Project 11540-0

Station 92+50
East Levee
Stratigraphy

FIGURE
H-3


New Levee Fill - Unit Weight 120 pcf
El. 168.3
El. 166.0
Levee Fill - Unit Weight 115 pcf; OCR 10; RR 0.06
El. 155.0
Stiffer Fine Grained Alluvium - Unit Weight 120 pcf; OCR 3; RR 0.06
El. 146.0
Coarse Grained Alluvium < 5% Fines < 12%

K:\11540-0 SCVWD Llagas Creek Geotech\Analyses\Llagas Creek Calc Packages\Appendix_Settlement\Figure H-1 to H-4 Typical Levee Stratigraphy.dwg

GEI Consultants

Lower Llagas Creek Capacity
Restoration Capital Project
Santa Clara County, California

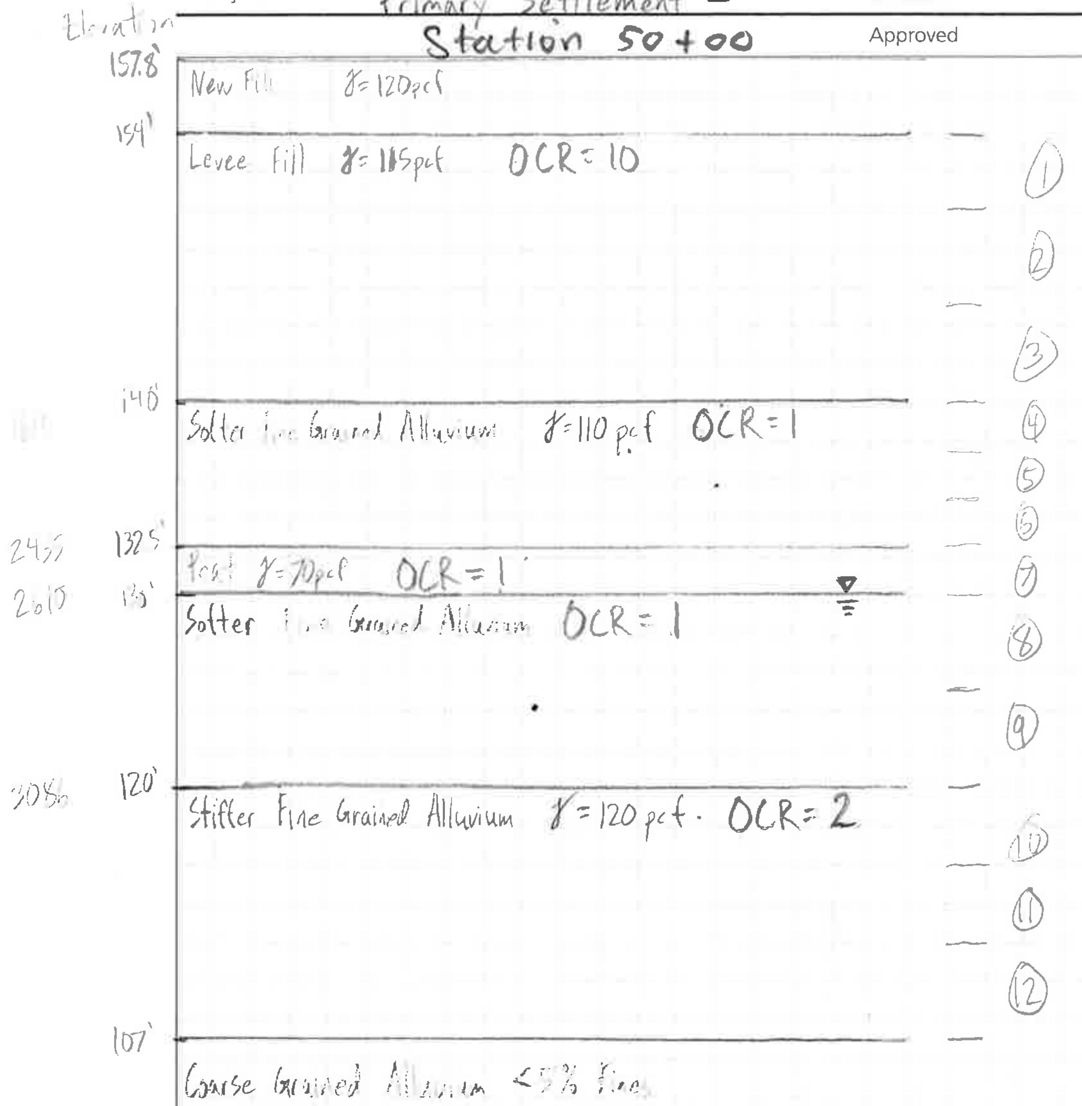
GEI Project 11540-0

Station 106+50 Typical Levee Stratigraphy

FIGURE
H-4

GEI Consultants

		Project Lower Llagas Creek	Page 1/4 (H-5)
Client	SCVWD	By T. Haynes	Date 5/31/12
Subject	Primary Settlement - Station 50+00	Checked	Date
		Approved	Date


Elevation
157.8'
New Fill γ=120pcf
154'
Levee Fill γ=115pcf OCR=10
①
②
③
140'
Softer Fine Grained Alluvium γ=110 pcf OCR=1
④
⑤
⑥
2455 132.5'
Peat γ=70pcf OCR=1
2610 130'
Softer Fine Grained Alluvium OCR=1
⑦
⑧
⑨
3086 120'
Stiffer Fine Grained Alluvium γ=120 pcf. OCR=2
⑩
⑪
⑫
107'
Coarse Grained Alluvium <5% Fines

at midheight of Layer

	H	σ'_{z_0}	σ'_{z_f}	Soil Name	Case	CR	RR	$(\delta_c)_{ult}$ (ft)
①	4'	230	686	Levee Fill	OC	–	0.07	0.133
②	5	748	1204	Levee Fill	OC	–	0.07	0.072
③	5	1323	1779	Levee Fill	OC	–	0.07	0.045
④	2.5	1748	2204	Softer FGA	NC	0.30	–	0.076
⑤	2.5	2023	2479	Softer FGA	NC	0.30	–	0.066
⑥	2.5	2298	2754	Softer FGA	NC	0.30	–	0.059
⑦	2.5	2523	2979	Peat	NC	0.50	–	0.090
⑧	5	2729	3185	Softer FGA	NC	0.30	–	0.101
⑨	5	2967	3423	Softer FGA	NC	0.30	–	0.093
⑩	4	3201	3657	Stiffer FGA	OC	–	0.06	0.014
⑪	4	3432	3888	Stiffer FGA	OC	–	0.06	0.013
⑫	5	3691	4147	Stiffer FGA	OC	–	0.06	0.015

$\Sigma = 0.777' \Rightarrow 9.3''$

FIGURE H-5

GEI Consultants

Project 11540-0 Page 2/4 (H-6)

Client SCVWD By T. Haynes Date

Subject Settlement Lower Llagas 92+50 West Levee Checked Date

Approved Date

El. 166'

El. 164'

New Fill $\gamma = 120pcf$

Levee Fill $\gamma = 115pcf$

OCR = 10

① ② ③ ④

El. 150'

Stiffer Fine Grained Alluvium $\gamma = 120pcf$

OCR = 2

⑤ ⑥

El. 144'

Softer Fine Grained Alluvium $\gamma = 110pcf$

OCR = 1

⑦ ⑧

El. 140'

Coarse Grained Alluvium 5% < Fines < 12% ▽

At midheight of layer

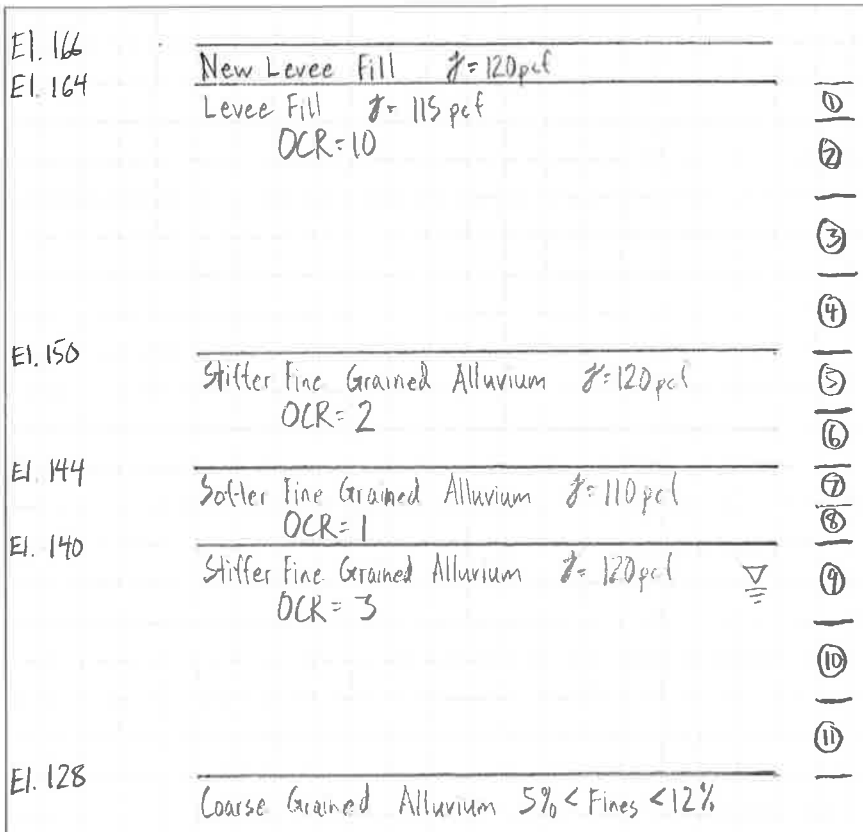
	H (ft)	σ'_{zo} (pcf)	σ'_{zf} (pcf)	Soil Name	Case	CR	RR	$(\delta_c)_{ULT}$ (ft)
①	2'	115	355	Levee Fill	OC	—	0.07	0.069
②	4'	460	700	Levee Fill	OC	—	0.07	0.051
③	4'	920	1160	Levee Fill	OC	—	0.07	0.028
④	4'	1380	1620	Levee Fill	OC	—	0.07	0.019
⑤	3'	1790	2030	Stiffer FGA	OC	—	0.06	0.010
⑥	3'	2150	2390	Stiffer FGA	OC	—	0.06	0.008
⑦	2'	2440	2680	Softer FGA	NC	0.30	—	0.024
⑧	2'	2660	2900	Softer FGA	NC	0.30	—	0.023

$\Sigma = 0.232' \Rightarrow 2.8''$

FIGURE H-6

GEI Consultants

Project 11540-0 Page 3/4 (H-7)
Client SCVWD
By T. Haynes Date
Subject Settlement Lower Llagas 92+50 East Levee
Checked Date
Approved Date


El. 166
El. 164
New Levee Fill γ = 120 pcf
Levee Fill γ = 115 pcf
OCR = 10
El. 150
Stiffer Fine Grained Alluvium γ = 120 pcf
OCR = 2
El. 144
Softer Fine Grained Alluvium γ = 110 pcf
OCR = 1
El. 140
Stiffer Fine Grained Alluvium γ = 120 pcf
OCR = 3
El. 128
Coarse Grained Alluvium 5% < Fines < 12%
①
②
③
④
⑤
⑥
⑦
⑧
⑨
⑩
⑪

At Midheight of layer

	H (ft)	σ'_{z0} (pcf)	σ'_{zf} (pcf)	Soil Name	Case	CR	RR	$(\delta_c)_{ult}$ (ft)
①	2	115	355	Levee Fill	OC	—	0.07	0.069
②	4	460	700	Levee Fill	OC	—	0.07	0.051
③	4	920	1160	Levee Fill	OC	—	0.07	0.028
④	4	1380	1620	Levee Fill	OC	—	0.07	0.019
⑤	3	1790	2030	Stiffer FGA	OC	—	0.06	0.010
⑥	3	2150	2390	Stiffer FGA	OC	—	0.06	0.008
⑦	2	2440	2680	Softer FGA	NC	0.30	—	0.024
⑧	2	2660	2900	Softer FGA	NC	0.30	—	0.023
⑨	4	3010	3250	Stiffer FGA	OC	—	0.06	0.008
⑩	4	3240	3480	Stiffer FGA	OC	—	0.06	0.007
⑪	4	3471	3711	Stiffer FGA	OC	—	0.06	0.007

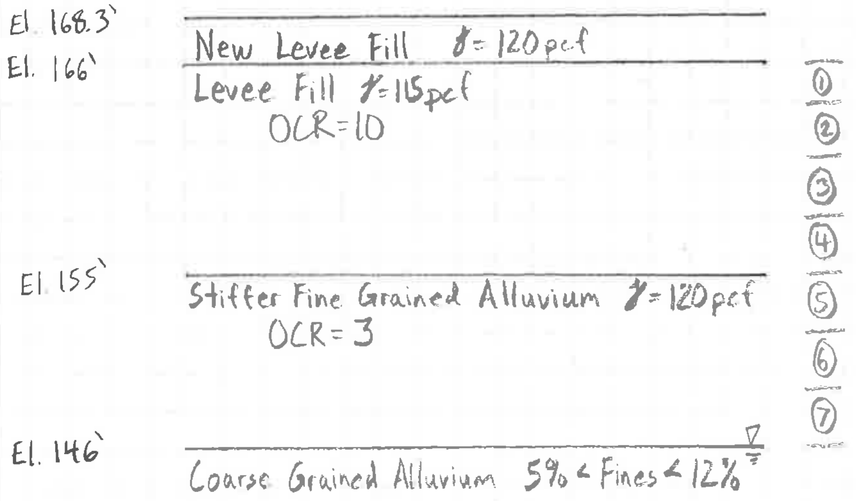
$\Sigma = 0.254' \Rightarrow 3.0''$

FIGURE H-7

GEI Consultants

Client	SCVWD	Project	11540-0
		Page	4/4 (H-8)
		By	T. Haynes
		Date	
Subject	Settlement Lower Llagas 106+50	Checked	
		Date	
		Approved	
		Date	

1265



El. 168.3'
El. 166'
New Levee Fill γ = 120 pcf
Levee Fill γ = 115 pcf
OCR = 10
El. 155'
Stiffer Fine Grained Alluvium γ = 120 pcf
OCR = 3
El. 146'
Coarse Grained Alluvium 5% < Fines < 12%
①
②
③
④
⑤
⑥
⑦

At midheight of layer

	H (ft)	σ'_{zo} (pcf)	σ'_{zf} (pcf)	Soil Name	Case	CR	RR	$(\delta)_{ULT}$ (ft)
①	2	115	391	Levee Fill	OC	–	0.07	0.074
②	3	403	679	Levee Fill	OC	–	0.07	0.048
③	3	748	1024	Levee Fill	OC	–	0.07	0.029
④	3	1093	1369	Levee Fill	OC	–	0.07	0.021
⑤	3	1445	1721	Stiffer FGA	OC	–	0.06	0.014
⑥	3	1805	2081	Stiffer FGA	OC	–	0.06	0.011
⑦	3	2165	2441	Stiffer FGA	OC	–	0.06	0.009

$\delta = 0.206' \Rightarrow 2.5''$

FIGURE H-8